FREIGHTLINER
Custom Chassis

SHUTTLE BUS CHASSIS

Maintenance Manual

STI-472-6
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SHUTTLE BUS CHASSIS MAINTENANCE MANUAL

Models: MBC
XBP
XBR
XBS

STI-472-6 (11/14)

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Foreword

Scheduled maintenance provides a key element for safe operation of your vehicle. A proper maintenance program also helps to minimize downtime and to safeguard warranties. This maintenance manual provides information necessary for years of safe, reliable, and cost-efficient vehicle operation.

IMPORTANT: The maintenance operations in this manual are **not all-inclusive**. Also refer to other component and body manufacturers' instructions for specific inspection and maintenance instructions.

Perform daily pre-trip inspection and maintenance as outlined in the vehicle operator's manual. Perform the operations in this maintenance manual at scheduled intervals based upon distance traveled or months of operation. Your authorized servicing dealer has the qualified technicians and equipment to perform this maintenance for you. Your dealership can also set up a scheduled maintenance program tailored specifically to your needs. Optionally, your dealership can assist you in learning how to perform the maintenance procedures in this manual.

IMPORTANT: Descriptions and specifications in this manual were in effect at the time of printing. Freightliner Custom Chassis Corporation (FCCC) reserves the right to discontinue models, and to change specifications or design at any time without notice and without incurring obligation. Descriptions and specifications contained in this publication provide no warranty, expressed or implied, and are subject to revision and editions without notice.

Refer to **www.Daimler-TrucksNorthAmerica.com** and **www.FreightlinerChassis.com** for more information, or contact Daimler Trucks North America LLC at the address below.

Environmental Concerns and Recommendations

Whenever you see instructions in this manual to discard materials, you should attempt to reclaim and recycle them. To preserve our environment, follow appropriate environmental rules and regulations when disposing of materials.

NOTICE: Parts Replacement Considerations

Do not replace suspension, axle, or steering parts (such as springs, wheels, hubs, and steering gears) with used parts. Used parts may have been subjected to collisions or improper use and have undetected structural damage.

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Daimler Trucks North America LLC
Service Systems and Documentation (CVI-SSD)
P.O. Box 3849
Portland, OR 97208–3849

Descriptions of Service Publications

Daimler Trucks North America LLC distributes the following major service publications in paper and electronic (via ServicePro®) formats.

Workshop/Service Manual

Workshop/service manuals contain service and repair information for all vehicle systems and components, except for major components such as engines, transmissions, and rear axles. Each workshop/service manual section is divided into subjects that can include general information, principles of operation, removal, disassembly, assembly, installation, and specifications.

Maintenance Manual

Maintenance manuals contain routine maintenance procedures and intervals for vehicle components and systems. They have information such as lubrication procedures and tables, fluid replacement procedures, fluid capacities, specifications, and procedures for adjustments and for checking the tightness of fasteners. Maintenance manuals do not contain detailed repair or service information.

Driver's/Operator's Manual

Driver's/operator's manuals contain information needed to enhance the driver's understanding of how to operate and care for the vehicle and its components. Each manual contains a chapter that covers pre-trip and post-trip inspections, and daily, weekly, and monthly maintenance of vehicle components. Driver's/operator's manuals do not contain detailed repair or service information.

Service Bulletins

Service bulletins provide the latest service tips, field repairs, product improvements, and related information. Some service bulletins are updates to information in the workshop/service manual. These bulletins take precedence over workshop/service manual information, until the latter is updated; at that time, the bulletin is usually canceled. The service bulletins manual is available only to dealers. When doing service work on a vehicle system or part, check for a valid service bulletin for the latest information on the subject.

IMPORTANT: Before using a particular service bulletin, check the current service bulletin validity list to be sure the bulletin is valid.

Parts Technical Bulletins

Parts technical bulletins provide information on parts. These bulletins contain lists of parts and BOMs needed to do replacement and upgrade procedures.

Web-based repair, service, and parts documentation can be accessed using the following applications on the AccessFreightliner.com website.

ServicePro

ServicePro® provides Web-based access to the most up-to-date versions of the publications listed above. In addition, the Service Solutions feature provides diagnostic assistance with Symptoms Search, by connecting to a large knowledge base gathered from technicians and service personnel. Search results for both documents and service solutions can be narrowed by initially entering vehicle identification data.

PartsPro

PartsPro® is an electronic parts catalog system, showing the specified vehicle's build record.

EZWiring

EZWiring™ makes Freightliner Custom Chassis Corporation, Freightliner, Sterling, Western Star, and Thomas Built Buses products' wiring drawings and floating pin lists available online for viewing and printing. EZWiring can also be accessed from within PartsPro.

Descriptions of Service Publications

Warranty-related service information available on the AccessFreightliner.com website includes the following documentation.

Recall Campaigns Recall campaigns cover situations that involve service work or replacement of parts in connection with a recall notice. These campaigns pertain to matters of vehicle safety. All recall campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

Field Service Campaigns Field service campaigns are concerned with non-safety-related service work or replacement of parts. All field service campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

Page Description

For a page example of the printed manual, see **Fig. 1**.

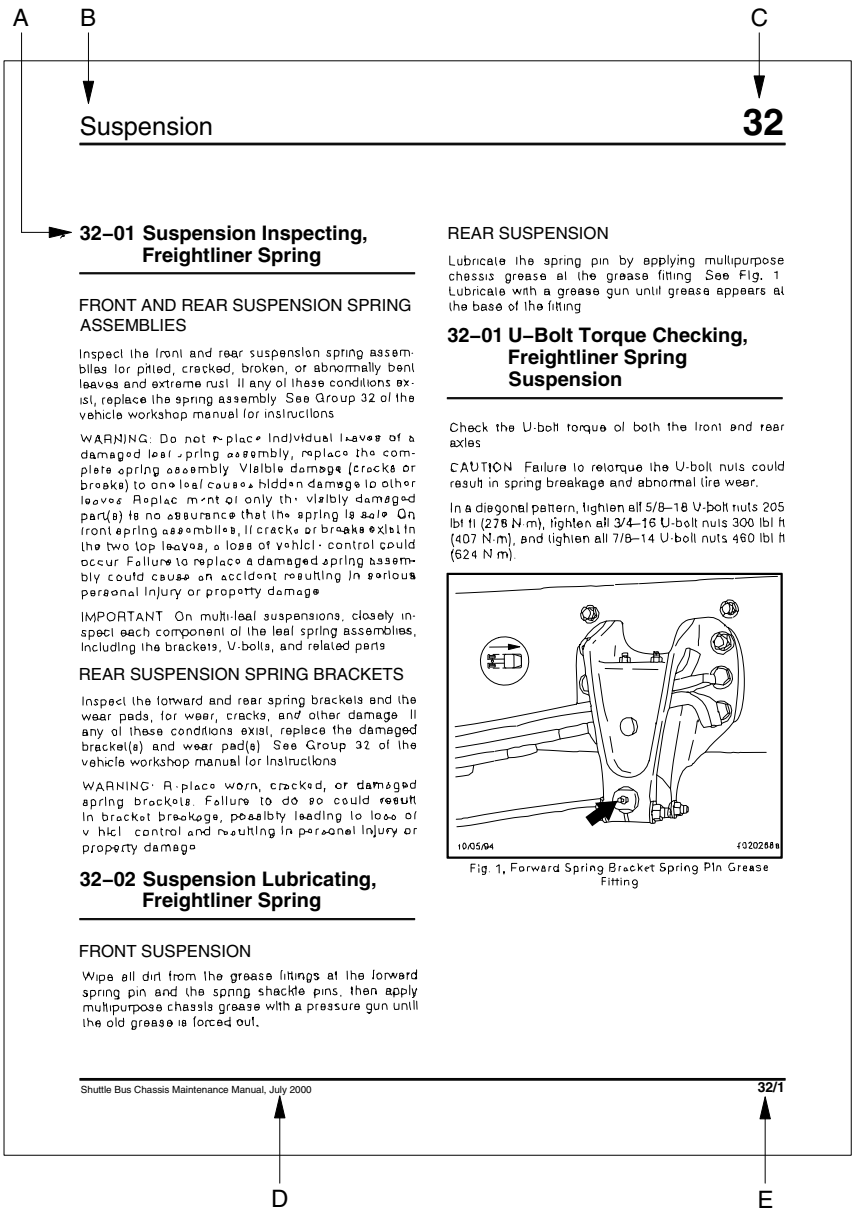
A
B
C
Suspension
32
32–01 Suspension Inspecting, Freightliner Spring
FRONT AND REAR SUSPENSION SPRING ASSEMBLIES
Inspect the front and rear suspension spring assemblies for pitted, cracked, broken, or abnormally bent leaves and extreme rust. If any of these conditions exist, replace the spring assembly. See Group 32 of the vehicle workshop manual for instructions.
WARNING: Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. On front spring assemblies, if cracks or breaks exist in the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.
IMPORTANT: On multi-leaf suspensions, closely inspect each component of the leaf spring assemblies, including the brackets, U-bolts, and related parts.
REAR SUSPENSION SPRING BRACKETS
Inspect the forward and rear spring brackets and the wear pads, for wear, cracks, and other damage. If any of these conditions exist, replace the damaged bracket(s) and wear pad(s). See Group 32 of the vehicle workshop manual for instructions.
WARNING: Replace worn, cracked, or damaged spring brackets. Failure to do so could result in bracket breakage, possibly leading to loss of vehicle control and resulting in personal injury or property damage.
32–02 Suspension Lubricating, Freightliner Spring
FRONT SUSPENSION
Wipe all dirt from the grease fittings at the forward spring pin and the spring shackle pins, then apply multipurpose chassis grease with a pressure gun until the old grease is forced out.
REAR SUSPENSION
Lubricate the spring pin by applying multipurpose chassis grease at the grease fitting. See Fig. 1. Lubricate with a grease gun until grease appears at the base of the fitting.
32–01 U–Bolt Torque Checking, Freightliner Spring Suspension
Check the U-bolt torque of both the front and rear axles.
CAUTION: Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.
In a diagonal pattern, tighten all 5/8–18 U-bolt nuts 205 lbf ft (278 N·m), tighten all 3/4–16 U-bolt nuts 300 lbf ft (407 N·m), and tighten all 7/8–14 U-bolt nuts 460 lbf ft (624 N·m).
10/05/94
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Fig. 1, Forward Spring Bracket Spring Pin Grease Fitting
Shuttle Bus Chassis Maintenance Manual, July 2000
32/1
D
E

08/03/2000 f020107

A. Maintenance Operation Number consists of the Group Number followed by the Sequence Number
B. Group Title
C. Group Number
D. Release Date
E. Group Number/Page Number

Fig. 1, Page Example of the Printed Manual

Maintenance Manual Contents

Group No.	Group Title
00	General Information
01	Engine
09	Air Intake
13	Air Compressor
15	Alternators and Starters
20	Engine Cooling/Radiator
26	Transmission
31	Frame and Frame Components
32	Suspension
33	Front Axle
35	Rear Axle
40	Wheels and Tires
41	Driveline
42	Brakes
46	Steering
47	Fuel
49	Exhaust
54	Electrical, Instruments, and Controls
83	Heater and Air Conditioner

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Determining Scheduled Maintenance Intervals	00–01
Maintenance Interval Table	00–03
Maintenance Operation Sets	00–04
Noise Emission Controls Maintenance	00–05
Vehicle Maintenance Schedule Table	00–02
Verification of Inspections Log	00–06

Description

Category I (urban transport) applies to vehicles that annually travel *up to* 20,000 miles (32 000 kilometers).

Category II (rural transport) applies to vehicles that annually travel *over* 20,000 miles (32 000 kilometers).

The table under *Vehicle Maintenance Schedule Table* shows the two categories of vehicle usage. For each category, the appropriate distance and time intervals are given for performing initial maintenance and for repeating each maintenance operation set (M1 through M3).

The table under *Maintenance Interval Table* shows which maintenance operation set must be performed at the actual distances (miles and kilometers) or actual months of operation for each maintenance category. The schedule of actual distances (and months) is based on the intervals given in the Vehicle Maintenance Schedule Table.

The table under *Maintenance Operation Sets* lists, in numerical order, the text reference numbers and descriptions of *all* maintenance operations, and indicates all maintenance operation sets at which each operation must be performed.

Use

Before placing your new vehicle in service, determine the maintenance category (Category I or II) that applies to your intended use of the vehicle. See the Vehicle Maintenance Schedule Table to determine the distance (or time) interval at which each maintenance operation set must be performed for your category of vehicle.

When the vehicle reaches the actual distance (or months) given for an interval, see the Maintenance Interval Table to find the maintenance operation set that applies to that interval. Then perform the maintenance operations listed in the applicable Maintenance Interval Operations table. Use the maintenance operation reference numbers to find instructions in the manual for completion of each operation.

Complete each maintenance operation set at the required interval. Then, when you have completed maintenance operation set M3 under the 12th Maintenance Number listed in the Maintenance Interval Table, repeat the pattern. The 13th Maintenance Number will begin at maintenance operation set M1, under the 1st Maintenance Number listed in the Maintenance Interval Table.

NOTE: When performing operations for the 13th Maintenance Number, complete the M1 operations only, not the Initial Maintenance operations.

To determine the distance/months for the 13th Maintenance Number, add your category's distance/months for the 1st Maintenance Number to the distance/months for the 12th Maintenance Number, then perform the operations listed in the applicable table in the Maintenance Interval Operations tables. For the 14th Maintenance Number, add the distance/months for the 2nd to the distance/months for the 12th; continue this pattern for each successive Maintenance Number.

Vehicle Maintenance Schedule Table: 00–02

Vehicle Maintenance Schedule Table

Vehicle Maintenance Schedule Table					
Description	**Maintenance Operation Set**	**Maintenance Intervals**			
		Frequency	**Miles**	**km**	**Months**
CATEGORY I (Urban Transport) vehicles that annually travel up to 20,000 miles (32 000 km)	Initial Maintenance (IM)	first	2500	4000	3
	Maintenance 1 (M1)	every	2500	4000	3
	Maintenance 2 (M2)	every	10,000	16 000	12
	Maintenance 3 (M3)	every	30,000	48 000	36
CATEGORY II (Rural Transport) vehicles that annually travel over 20,000 miles (32 000 km)	Initial Maintenance (IM)	first	5000	8000	3
	Maintenance 1 (M1)	every	5000	8000	3
	Maintenance 2 (M2)	every	20,000	32 000	12
	Maintenance 3 (M3)	every	60,000	96 500	36

Maintenance Interval Table: 00–03

Maintenance Interval Table

Maintenance Interval Table							
Maint. No.	Maint. Oper. Set	Category I			Category II		
		miles x 100	km x 100	months	miles x 100	km x 100	months
1st	IM + M1	25	40	3	50	80	3
2nd	M1	50	80	6	100	160	6
3rd	M1	75	120	9	150	240	9
4th	M2	100	160	12	200	320	12
5th	M1	125	200	15	250	400	15
6th	M1	150	240	18	300	480	18
7th	M1	175	280	21	350	560	21
8th	M2	200	320	24	400	640	24
9th	M1	225	360	27	450	720	27
10th	M1	250	400	30	500	800	30
11th	M1	275	440	33	550	885	33
12th	M3	300	480	36	600	965	36

Maintenance Operation Sets: 00–04

NOTE: Maintenance operations appearing in italics in this table are for noise emission control components. Numbers in this table are maintenance operation reference numbers matching those in the text of this manual.

REQUIRED MAINTENANCE OPERATION SET		IM	M1	M2	M3
Maintenance Operation Reference Number and Maintenance Operation					
01–01	*Engine-Support Fasteners Checking (Noise Emission Control)*				•
01–02	Engine Drive Belt Inspecting	•	•	•	•
09–01	Air Cleaner Inspecting and Replacing*			•	•
09–02	Air Intake System Inspecting	•	•	•	•
13–01	Air Compressor Inspection	•	•	•	•
15–01	Alternator, Battery, and Starter Connections Check			•	•
20–01	Radiator Cap Check			•	•
20–02	Radiator Pressure Flush and Coolant Change				•
20–03	*Eaton Viscous Fan Drive Check (Noise Emission Control)*			•	•
20–04	Mechanical Fan Drive Gearbox Oil Change			•	
20–05	Mechanical Fan Drive Gearbox Lubrication	•	•		
26–01	Transmission Breather Checking			•	•
26–02	Transmission Fluid and Filter Changing†				
26–03	Transmission Fluid Level Checking	•	•	•	•
31–01	Frame Fastener Torque Checking	•			•
32–01	Suspension Inspecting, Freightliner Spring	•	•	•	•
32–02	Suspension Lubricating, Freightliner Spring	•	•	•	•
32–03	U-Bolt Torque Checking, Freightliner Spring	•			•
32–04	Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)	•			•
32–05	Fastener Torque Checking, Freightliner AirLiner	•			•
32–06	Component Clearance Checking, Freightliner AirLiner	•			•
32–07	Component Inspecting and Operation Checking, Freightliner AirLiner				•
32–08	U-Bolt Torque Checking, Freightliner AirLiner	•			•
32–09	Shock Absorber Checking, Freightliner Spring				•
32–10	Torque Arm Bushing Checking, Freightliner AirLiner	•	•	•	•
32–11	Suspension Inspecting, Neway	•			•
32–12	ZF IFS Lubricating	•	•	•	•
33–01	Knuckle Pin Lubricating‡	•	•	•	•
33–02	Tie-Rod End Lubricating‡	•	•	•	•
33–03	Tie-Rod End Inspecting	•	•	•	•
33–04	Wheel Alignment Checking, Front Axle	•			
33–05	Oil-Filled Hubs Oil Level Checking	•	•	•	•

Maintenance Operation Sets: 00–04

REQUIRED MAINTENANCE OPERATION SET		IM	M1	M2	M3
Maintenance Operation Reference Number and Maintenance Operation					
33–06	Oil-Filled Hubs Oil Changing				•
33–07	Wheel End Inspection			•	
35–01	Axle Lubricant Level Checking	•	•	•	•
35–02	Axle Lubricant Changing and Magnetic Plug Cleaning§				
35–03	Axle Breather Checking	•	•	•	•
40–01	Wheel Nut Checking	•	•	•	•
41–01	Driveline Inspection and Lubrication	•	•	•	•
42–01	Air Dryer Checking			•	•
42–02	Air Dryer Desiccant and Coalescent Filter Replacing				•
42–03	Air Dryer Inspecting	•		•	•
42–04	Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV–2			•	•
42–05	Slack Adjuster Lubricating	•	•	•	•
42–06	Bendix Hydro-Max® Brake System Inspecting	•	•	•	•
42–07	Brake Lines Checking, Hydraulic Disc Brakes	•	•	•	•
42–08	Brake Lining Wear Checking, Hydraulic Disc Brakes	•	•	•	•
42–09	Camshaft Bracket Bushing Lubricating			•	•
42–10	Foot Brake Valve Actuator Lubricating, Bendix E–6	•		•	•
42–11	Relay Valve Checking, Midland	•	•	•	•
42–12	Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes¶	•	•	•	•
42–13	Brake Caliper Slide Pin Lubricating, Bosch Brakes**				
42–14	ABS Tone Rings Cleaning††	•	•	•	•
42–15	Drum Brake Shoe Roller Lubricating			•	•
42–16	Air Dryer Inspecting, Midland	•		•	•
42–17	Air Dryer Desiccant and Coalescent Filter Replacing, Midland‡‡				
42–18	Air-Actuated Parking Brake Cable Checking and Adjusting	•	•	•	•
42–19	Brake Inspection	•	•	•	•
46–01	Steering Driveline Lubricating	•	•	•	•
46–02	Drag Link Lubricating	•	•	•	•
46–03	Power Steering Reservoir Fluid Level Checking	•	•	•	•
46–04	Power Steering Reservoir Fluid and Filter Changing				•
46–05	Steering Gear Lubricating	•	•	•	•
47–01	Diesel Fuel Tank Draining and Vent Checking	•	•	•	•
47–02	Fuel/Water Separator Element Replacing			•	•
47–03	CNG Fuel Block Housing Draining	•	•	•	•
47–04	CNG Fuel Leak Testing	•	•	•	•

Maintenance Operation Sets: 00–04

REQUIRED MAINTENANCE OPERATION SET		IM	M1	M2	M3
Maintenance Operation Reference Number and Maintenance Operation					
47–05	CNG Fuel Tank Visual Inspecting§§				
47–06	CNG High-Pressure Fuel Filter Replacing	•	•	•	•
47–07	CNG Low-Pressure Fuel Filter Replacing	•	•	•	•
47–08	Inline Fuel Strainer Replacing, Cummins Engine			•	•
49–01	*Exhaust System Inspecting (Noise Emission Control)*	•	•	•	•
54–01	Ground Cables Checking and Cleaning			•	•
54–02	Battery Voltage Checking	•	•	•	•
83–01	Air Conditioner Checking, R-134a Refrigerant System	•	•	•	•

* Inspect the air filter every 6 months. Replace the air filter every 12 months, or when filter restriction reaches 25 inH_20 (if equipped with an air restriction gauge).

† For oil and filter change intervals, see the applicable Allison Operator's Manual.

‡ For Detroit axles, complete this procedure once a year or at the following applicable interval, whichever comes first: every 5000 miles (8000 km) for Category I vehicles; or every 10,000 miles (16 000 km) for Category II vehicles.

§ For Detroit™ rear axles with petroleum-based oil, change the lubricant every 100,000 miles (161 000 km) or every 12 months, whichever comes first; if synthetic oil is used, change the lubricant every 250,000 miles (402 000 km) or every 36 months, whichever comes first. For Meritor rear axles with petroleum-based oil, change the lubricant at 100,000 miles (161 000 km) or at 12 months of service, whichever comes first, and every 24 months thereafter; if synthetic oil is used, change the lubricant every 250,000 miles (402 000 km) or every 36 months, whichever comes first.

¶ IMPORTANT: Lubricate every 6 months "or" every 18,000 miles (30 000 km), whichever comes first.

** See the "Bosch Pin Slide Disc Brakes Service Manual" for more information.

†† This operation applies specifically to vehicles used during winter months in areas where corrosive materials are used on the highways.

‡‡ Replace the desiccant and coalescent filter every 18,000 miles (30 000 km) or every 18 months.

§§ Visually inspect the fuel tank every 6 months. The fuel tank must be replaced every 15 years.

General Information

Federal Law, Part 205: Transportation Equipment Noise Emission Controls

Part 205, Transportation Equipment Noise Emission Controls, requires the vehicle manufacturer to furnish, with each new vehicle, such written instructions for the proper maintenance, use, and repair of the vehicle by the ultimate purchaser to provide reasonable assurance of the elimination or minimization of noise emission degradation throughout the life of the vehicle. In compliance with the law, the noise emission controls maintenance information located in each applicable group of this manual, in conjunction with the vehicle workshop manual, provides these instructions to owners.

Normal Vehicle Use

The maintenance instructions contained in this manual are based on average vehicle use and normal operating conditions. Unusual vehicle operating conditions may require service at more frequent intervals.

Recommendations for Replacement Parts

Replacement parts used for maintenance or repair of noise emission controls should be genuine Alliance parts. If other than genuine Alliance parts are used for replacement or repair of components affecting noise emission control, the owner should be sure that such parts are warranted by their manufacturer to be equivalent to genuine Alliance parts in performance and durability.

Freightliner Noise Emissions Warranty

See the vehicle owner's warranty information book for warranty information concerning noise emission controls.

Tampering With the Noise Controls is Prohibited

Federal law prohibits the following acts or the causing thereof: (1) the removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new vehicle for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) the use of the vehicle after such device or element of design has been removed or rendered inoperative by any person. Among those acts presumed to constitute tampering are the acts listed below:

A. Removal of engine noise-deadening panels.

B. Removal of, or rendering inoperative, the engine speed governor so as to allow engine speed to exceed manufacturer's specifications.

C. Removal of, or rendering inoperative, the fan clutch, including by-passing the control on any thermostatic fan drive to cause it to operate continuously.

D. Removal of the fan shroud.

E. Removal of, or rendering inoperative, exhaust system components, including exhaust pipe clamping.

F. Removal of air intake components.

G. Removal of hood liners (noise-deadening panels).

Maintenance Instructions

Scheduled intervals are in the maintenance table in this Group. A "Verification of Inspections Log" follows, and should be filled in each time the noise emission controls on the vehicle are maintained or repaired.

Verification of Inspections Log: 00–06

Verification of Inspections Log

Verification of Inspections Log, Groups 01, 20, and 49				
Date	**Mileage**	**Repair Description**	**Cost**	**Repair Facility**
Group 01 — Engine Support Fasteners				
Group 20 — Engine Cooling Fan Drive				
Group 49 — Exhaust System				

Index, Alphabetical

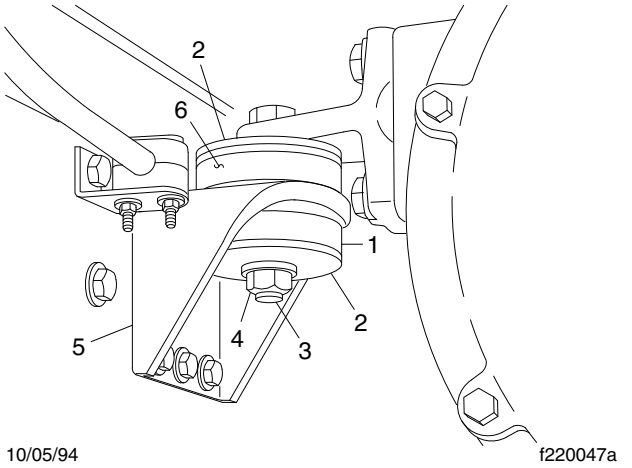
Title of Maintenance Operation (MOP)	MOP Number
Engine Drive Belt Inspecting	01–02
Engine-Support Fasteners Checking (Noise Emission Control)	01–01

01–01 Engine-Support Fasteners Checking (Noise Emission Control)

Mounts should be inspected when the engine is removed for service. Perform the following check.

Check the front and rear engine-support fasteners for tightness. See **Fig. 1**. See **Chapter 14** of the *Shuttle Bus Chassis Operator's Manual* for torque specifications, or take the vehicle to an authorized Freightliner dealer.

NOTE: At engine overhaul, and whenever the engine has been removed, inspect the lower and upper isolators and replace them if they are worn. See **Fig. 1**. See **Section 01.02** of the *Shuttle Bus Chassis Workshop Manual* for procedures, or take the vehicle to an authorized Freightliner dealer.



1. Lower Isolator
2. Engine Support Washer
3. Capscrew
4. Hexnut
5. Engine Mount
6. Upper Isolator

Fig. 1, Rear Engine Mount

01–02 Engine Drive Belt Inspecting

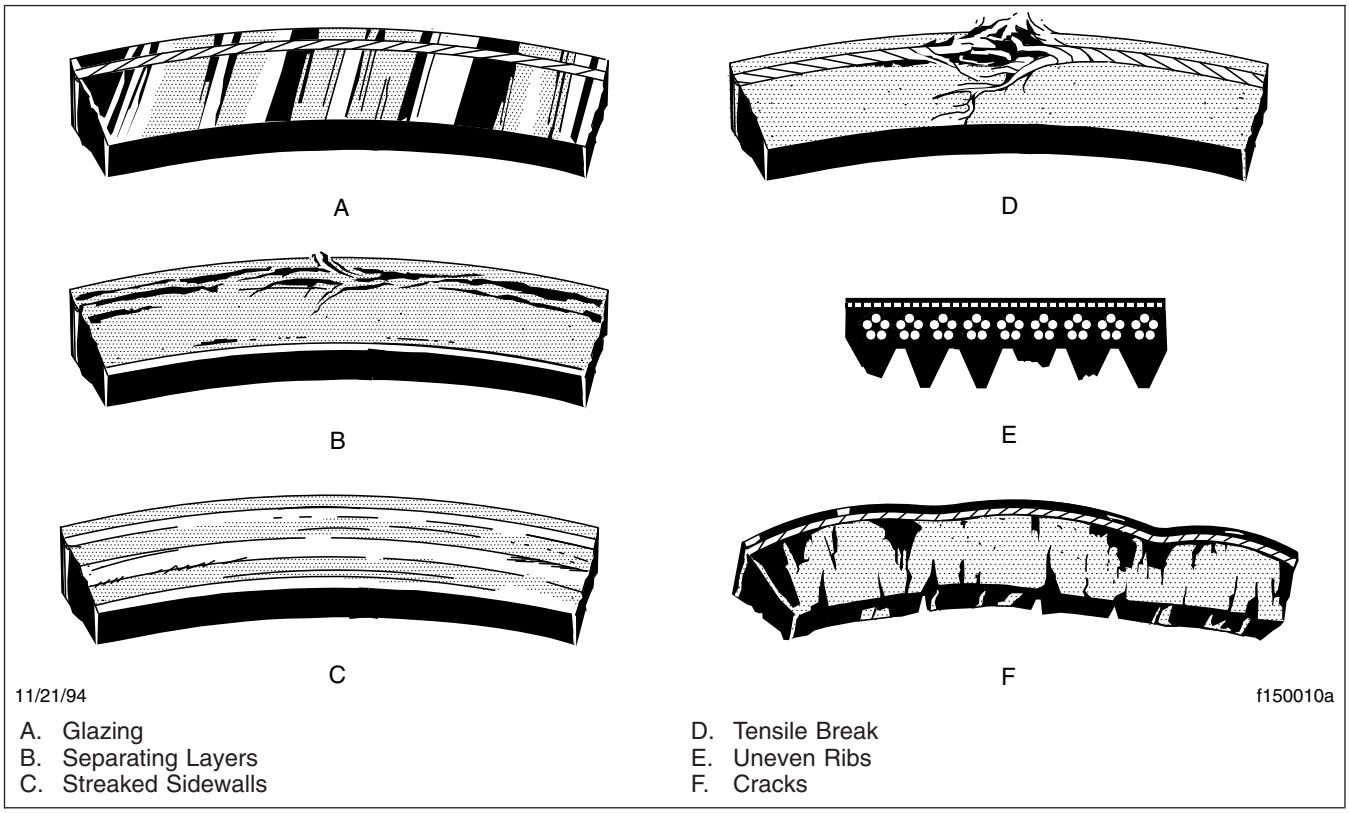
⚠ WARNING

The engine and the belt must be cool before you check the belt. Handling a hot belt can cause personal injury.

Worn or loose drive belts may cause premature bearing failure or engine overheating. Excessive tension, or too little tension on the belt may result in excessive and premature belt wear. Poly-V belts, or serpentine belts, are retained by a belt tensioner that requires no tension adjustment. Replace the engine drive belt if any conditions described in the visual description are found. V-belts are installed as individual belts, and as matched sets. When replacing a matched set of belts, always replace both belts at the same time. Matched belts must be from the same manufacturer. To inspect a belt, gently twist the belt to view the belt sidewalls and bottom. Visually inspect all drive belts for the following conditions, then perform the belt tension inspection.

Visual Inspection

1. Inspect the belt for glazing. See **Fig. 2**, Ref. A. Glazing is indicated by shiny sidewalls, and is caused by friction created when a loose belt slips in the pulleys. It can also be caused by oil or grease contamination on the pulleys.
2. Check the belt for ply separation. See **Fig. 2**, Ref. B. Oil, grease, or belt dressing can cause the belt to fall apart in layers. Repair any oil or coolant leaks that are affecting the belts before replacing the drive belts. Do not use belt dressing on any belt.
3. Check the belt for a jagged or streaked sidewall. See **Fig. 2**, Ref. C. Jagged or streaked sidewalls are the result of foreign objects, such as sand or gravel in the pulley, or a rough pulley surface.
4. Check for tensile breaks (breaks in the cord body). See **Fig. 2**, Ref. D. Cuts in a belt are usually caused by foreign objects in the pulley, or by prying or forcing the belt during removal or installation.
5. Check for uneven ribs on serpentine (poly-V) belts. See **Fig. 2**, Ref. E. Foreign objects in the



A. Glazing
B. Separating Layers
C. Streaked Sidewalls
D. Tensile Break
E. Uneven Ribs
F. Cracks

Fig. 2, Drive Belt Replacement Conditions

pulley will erode the undercord ribs, causing the belt to lose its gripping power.

6. Check the drive belts for cracks. See **Fig. 2**, Ref. F. Small irregular cracks are usually the signs of an old belt.
7. Visually inspect the pulleys for excessive play or wobble. Excessive play or wobble indicates a failure of the pulley bearing. Check for belt squealing or squeaking. Replace the bearings as necessary.

NOTE: If it is difficult to distinguish the location of a supposed bearing noise, obtain a stethoscope and place it on the component being checked, not the pulley, to isolate the area from outside interference.

8. Inspect all pulleys for foreign objects, oil, or grease in the grooves.

Belt Tension Inspection

Spring-Tension Type

On belts equipped with a spring tensioner, the belt tension is automatically adjusted. Check that the tensioner is holding tension on the belt by inserting the end of a breaker bar in the 1/2-inch square hole on the forward face of the tensioner, and rotating the tensioner down, away from the belt. When the breaker bar is slowly released, the tensioner should return to its original position. If not, see **Group 01** of the *Shuttle Bus Chassis Workshop Manual* for replacement instructions, or take the vehicle to an authorized Freightliner dealer.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Air Cleaner Inspecting and Replacing	09–01
Air Intake System Inspecting	09–02

09–01 Air Cleaner Inspecting and Replacing

IMPORTANT: Due to the variety of possible driving conditions (dirt roads, paved roads, etc.), it is critical to check the air restriction indicator, if so equipped. If the vehicle is not equipped with an air restriction indicator, inspect all components of the air intake system and air filter every six months. Replace the air filter every 12 months, or when filter restriction reaches 25 inH_20 (if equipped with an air restriction indicator). **More frequent inspections and/or filter replacement may be needed if your vehicle is being operated in a dusty environment, to avoid damaging the vehicle.**

NOTE: Remove and visually inspect the air filter for obvious damage such as holes, cuts, or dents. Remove loose debris, such as leaves or pine needles, from the filter housing.

Inspect the air cleaner for holes or tears at the recommended interval. If the air cleaner is damaged, replace it. See **Group 09** of the *Shuttle Bus Chassis Workshop Manual* for removal and installation procedures, or take the vehicle to an authorized Freightliner dealer. A typical air cleaner mounting is shown in **Fig. 1**.

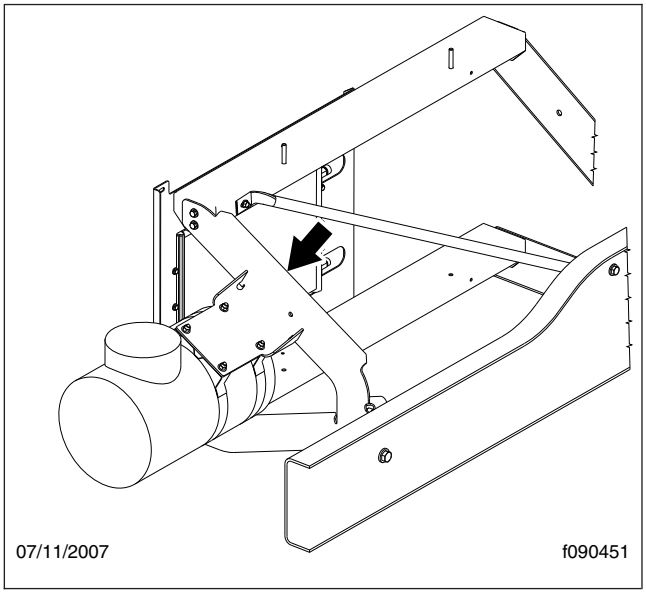


Fig. 1, Air Cleaner Mounting

Engine damage can occur if the air intake system is not properly maintained. Use the air intake restriction indicator to check for air intake system damage or leaks. See **Fig. 2**. Make sure the engine is off and note the existing reading on the indicator. Start the engine and take a short test drive. Check the indicator again and note the level of restriction on the indicator. A decrease from the previous level of restriction or a very low air restriction indicator reading (0 to 4 inH_2O) could indicate an air intake system problem such as a damaged air filter, loose or disconnected air intake piping, or a disconnected or damaged air restriction indicator.

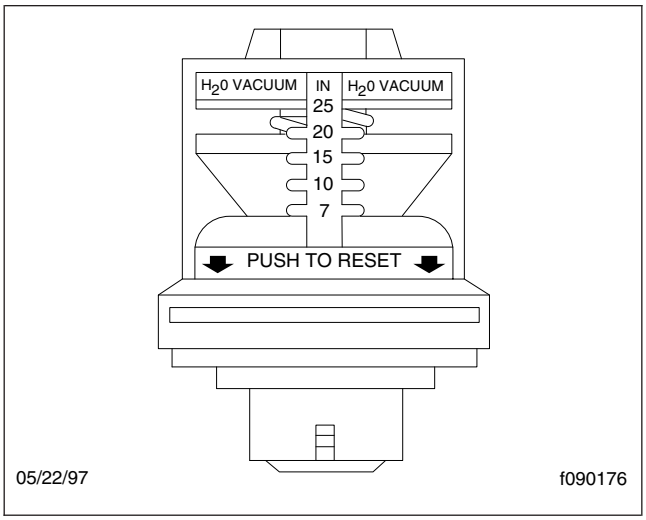


Fig. 2, Air Restriction Indicator

Replace the air filter at the recommended interval, or when filter restriction reaches 25 inH_2O. See the *Shuttle Bus Chassis Operator's Manual* for specific restriction values for your engine. See **Group 09** of the *Shuttle Bus Chassis Workshop Manual* for removal and installation procedures, or take the vehicle to an authorized Freightliner dealer.

09–02 Air Intake System Inspecting

Check the air intake system for damaged or cracked hoses and for loose clamps. Make repairs as necessary.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Air Compressor Inspection	13–01

13–01 Air Compressor Inspection

1. Inspect the air compressor intake hoses and connections at the air intake and air compressor for physical damage. If needed, change the hoses, and/or tighten or replace the connections.
2. Inspect the coolant supply and return lines for tight connections. Tighten the connections and replace the lines and fasteners if needed.
3. For the air governor, inspect the piping and connections for leaks. Replace gaskets and faulty components as needed.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Alternator, Battery, and Starter Connections Check	15–01

15–01 Alternator, Battery, and Starter Connections Check

⚠ WARNING

Batteries release explosive gas as a by-product of their chemical activity. Do not smoke when working around batteries. Put out all flames and remove any source of sparks or intense heat. Make sure the battery compartment is completely vented before disconnecting or connecting the battery cables.

Battery acid is extremely harmful if splashed in the eyes or on the skin. Always wear a face shield and protective clothing when working around batteries.

Damaged, chafed, or kinked wiring can cause electrical short-circuits and lead to fires, causing property damage, injury, or death. Clean, inspect, and maintain wiring and connections carefully.

1. Disconnect the batteries.
2. Check the tightness of the alternator bracket fasteners and alternator mounting fasteners; tighten the fasteners as needed. For torque values, see **Group 15** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
3. Check that all electrical connections at the alternator and starter are clean. Clean and tighten all charging system electrical connections as needed. Spray each electrical connection at the alternator and starter with dielectric red enamel.

   Trace and inspect all wiring and cables connected to:

   - alternator
   - starter and depopulation studs
   - batteries
   - magnetic switch
   - cab
   - jump-start studs
   - battery isolation relays
   - battery shutoff switches
4. Check wires and cables for wear, chafing, kinks, discolored insulation, or loose clamps or ties. Find the cause of any problems and repair, replace, and reroute wires and clamps as necessary.

IMPORTANT: Ensure that wires and cables are not near any heat sources; if they are, reroute them.

5. Clean all circuit breakers and relays.
6. Check the alternator wiring for missing insulation, kinks, and heat damage. Replace or repair as needed.
7. On the bundled cable that runs from the batteries to the starter, ensure that tie straps are installed at least every 12 inches (30 cm). Replace any missing tie straps, and add tie straps where spacing between them exceeds 12 inches (30 cm).
8. Ensure that all cables have sufficient slack to allow for engine movement, and that there is no force on any wiring connectors.
9. If any convoluted tubing is damaged, check the wiring inside it. Replace any damaged or missing convoluted tubing.
10. Inspect the battery cables for wear, and replace as needed. Clean the cable connector terminals with a wire brush. See **Group 54** of the vehicle *Workshop Manual* for troubleshooting instructions, and for adjustment, repair, or replacement instructions, or take the vehicle to an authorized Freightliner dealer.

    10.1 Clean and tighten the battery ground cable, terminal, and clamps.

    10.2 Inspect the retainer assembly (or battery hold-downs) and the battery box. Replace worn or damaged parts. Remove any corrosion with a wire brush, and wash with a weak solution of baking soda and water. Rinse with clean water, then dry. Paint the retainer assembly, if needed, to prevent rusting.

    10.3 Check that foreign objects, such as stones, bolts, and nuts, are removed from the battery box.

    10.4 After cleaning, connect the cables to the batteries, and tighten them to the torque

specifications listed on the battery, generally 10 to 15 lbf·ft (14 to 20 N·m).

10.5 Coat the battery terminals with dielectric grease.

11. Check the terminals on the battery shut-off switch and the starter relay. Make sure that the terminal connections are clean and tight. Coat the terminal connections with dielectric red enamel after cleaning.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Eaton Viscous Fan Drive Check (Noise Emission Control)	20–03
Mechanical Fan Drive Gearbox Lubrication	20–05
Mechanical Fan Drive Gearbox Oil Change	20–04
Radiator Cap Check	20–01
Radiator Pressure Flush and Coolant Change	20–02

20–01 Radiator Cap Check

⚠ WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

The radiator cap is the most often ignored part in the cooling system. If it is suspect, replace it. An inspection means checking the cap with a pressure tester. A radiator cap in good condition will not open below 9 psi (62 kPa). A visual check is also in order: look for signs of deterioration of the inner gasket. Also look for cracks or breaks in the spring retainer in the cap and for corrosion or deposits on the spring itself. If the spring is not in perfect condition, it has probably lost tension; replace it.

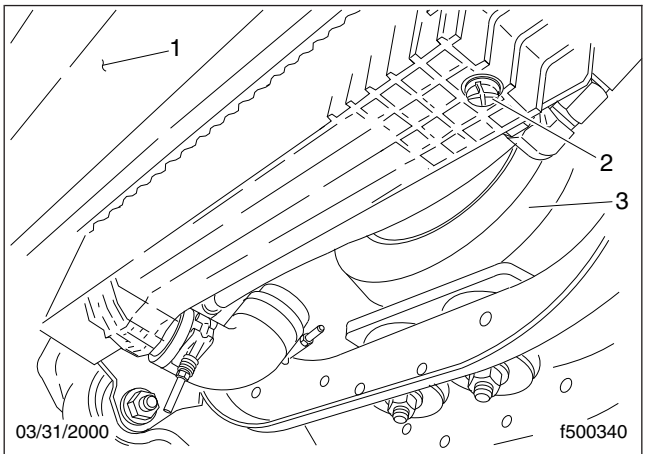
20–02 Radiator Pressure Flush and Coolant Change

NOTE: For additional instructions on cleaning and flushing the cooling system, see the engine manufacturer's maintenance and operation manual.

⚠ WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

1. Drain the radiator.
   - 1.1 Remove the surge tank cap.
   - 1.2 Remove the plug from the bottom of the radiator on the left side of the tank to drain the engine coolant. See **Fig. 1**.
2. Disconnect the radiator inlet and outlet hose connections.
3. Flush the radiator.
   - 3.1 Attach a flushing gun nozzle to the radiator outlet.
   - 3.2 Run water in until the radiator is full.
   - 3.3 Apply no more than 20 psi (138 kPa) air pressure intermittently to help dislodge sediment buildup in the core.



NOTE: Front radiator shown; other models will be similar.

1. Bumper
2. Radiator Drain Plug
3. Engine

Fig. 1, Radiator Drain Plug

⚠ CAUTION

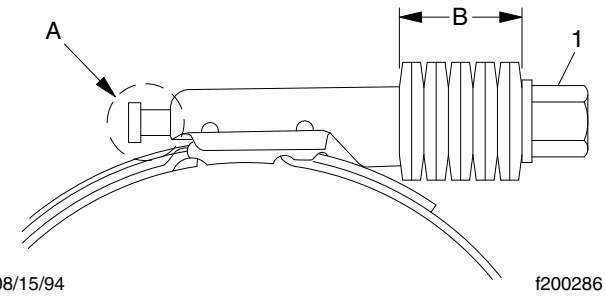
When flushing the radiator, do not apply more than 20 psi (138 kPa) air pressure. Excessive pressure can damage the radiator or heater core.

4. Drain the radiator. Then, flush the radiator until clean water flows from it. Remove the flushing gun.
5. Install the plug in the bottom of the radiator.
6. Connect the hoses. When you install Breeze Constant-Torque hose clamps, the clamps must be tightened to the correct torque. The screw tip of the clamp must extend about 1/4 inch (6 mm) from the clamp housing, and the belleville washer stacks must be collapsed almost flat. See **Fig. 2**. Use a torque wrench to install these hose clamps. The correct installation torque for Breeze Constant-Torque hose clamps is as follows:

   For hose clamps with a 5/16-inch tightening screw hex: 40 lbf·in (460 N·cm).

   For hose clamps with a 3/8-inch tightening screw hex: 90 lbf·in (1020 N·cm).

NOTE: All hose clamps will lose torque after installation due to "compression set." However, when correctly installed, Breeze Constant-Torque clamps will hold enough torque to auto-



A. The screw tip must extend about 1/4 inch (6 mm).
B. The belleville washer stacks must be collapsed almost flat.
1. Tightening Screw Hex

Fig. 2, Breeze Constant-Torque Hose Clamp

matically adjust and keep consistent sealing pressure. During vehicle operation and shutdown, the screw tip may adjust according to temperature and pressure changes. The torque may need to be adjusted for individual applications.

IMPORTANT: On vehicles with EPA07-compliant engines, the coolant capacity varies depending on the engine and accessory installation. After servicing the cooling system, always verify that the coolant level is between the MIN and MAX lines on the surge tank.

7. Fill the radiator with coolant.

   Use a mixture of 50 percent water and 50 percent corrosion-inhibiting antifreeze to protect the engine to –34°F (–37°C) year round.

   See **Table 1** for engine cooling system capacities and **Table 2** for approved antifreezes.

Coolant Capacities	
Engine Make and Model	**Radiator Core and System Capacity: quarts (liters)***
Cummins B Series and ISB	30.5 (28.9)

* System capacity includes all hoses, fittings, and the heater core.

Table 1, Coolant Capacities

Approved Coolants	
Coolant Manufacturer	**Coolant Designation***
Old World Industries	Fleet Charge®
Texaco	JC04 Antifreeze
Van Waters and Rogers Ltd. (Canada)	Diesel Antifreeze No. 6038

* Freightliner-approved antifreeze must meet one of the following conditions: A. Ethylene glycol solution that meets GM 6038–M Engineering Standards. B. Ethylene glycol solution that has less than 0.1% anhydrous sodium metasilicate, and meets either GM 1825–M or GM 1899–M Engineering Standards.

Table 2, Approved Coolants

20–03 Eaton Viscous Fan Drive Check (Noise Emission Control)

⚠ CAUTION

If the fan drive assembly is damaged, replace the unit as soon as possible. Operating a seized or otherwise damaged clutch reduces fuel economy, and could cause serious engine damage.

See **Section 20.02** of the *Shuttle Bus Chassis Workshop Manual* for replacement instructions, or take the vehicle to an authorized Freightliner dealer.

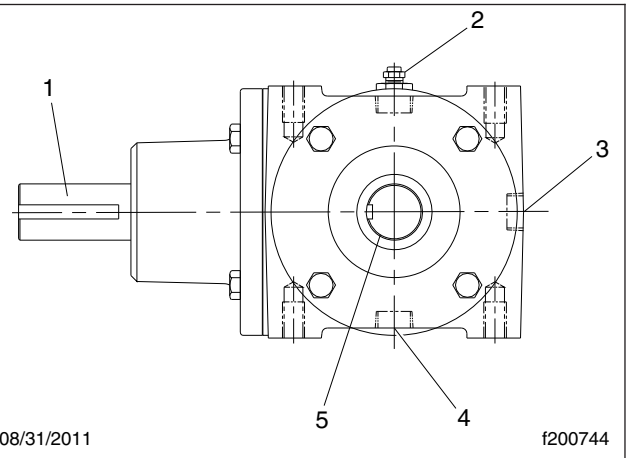
1. With the engine shut down, rotate the fan at least one full turn by hand. It should have a smooth, steady drag. If it does not, replace the fan clutch.
2. Check for physical damage to the fan or fan shroud.
3. At the fan clutch mounting:
   - 3.1 Check for correct drive belt alignment and tension. For specifications, see **Group 01** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
   - 3.2 Check for wear of the fan clutch bearings. There should be no side-to-side or in-and-out movement of the fan clutch.
   - 3.3 Do all of the checks in **Section 20.00** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

20–04 Mechanical Fan Drive Gearbox Oil Change

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Place a drain pan under the fan drive gearbox.

IMPORTANT: Label the plugs as they are removed. The breather/fill plug must always be installed in the top of the gearbox, opposite the drain plug.

3. Remove the drain plug and breather/fill plug, shown in **Fig. 3**, to begin draining the oil.



1. Pinion Shaft
2. Breather/Fill Plug
3. Oil Level Plug
4. Drain Plug
5. Cross-Shaft

Fig. 3, Mechanical Fan Drive Gearbox

4. Remove the oil level plug. See **Fig. 3**.
5. Flush the fan drive gearbox with an approved nonflammalbe, nontoxic solvent such as:
   - Lubriplate Syn Flush
   - Lubriplate Pure Flush
   - Whitmore's Flushing Oil
   - Medallion™ Flushing Oil Kosher
6. Using degreaser, clean the thread on the drain hole and drain plug.
7. Install the drain plug.
8. Fill the fan drive gearbox with Mobil® Delvac 75W–90 lubricant until the lubricant starts to come out of the oil level plug hole.
9. Using degreaser, clean the thread on the oil level and fill holes and both plugs.
10. Install the plugs, making certain that the breather/fill plug is used in the fill plug hole.

20–05 Mechanical Fan Drive Gearbox Lubrication

U-Joint Lubrication

1. Wipe all old grease and dirt from each U-joint grease fitting.
2. Use a hand-type grease gun, or a high-pressure gun with a low-pressure adaptor, to lubricate the U-joints. See **Fig. 4**.

NOTE: If a low-pressure adaptor is not used with the high-pressure gun, the U-joints may not receive enough lubricant.

3. Using lithium 12-hydroxy stearate grease (NLGI grade 2, with EP additives and meeting ASTM D4950 LB specifications), lubricate until new grease can be seen at both U-joint seals.

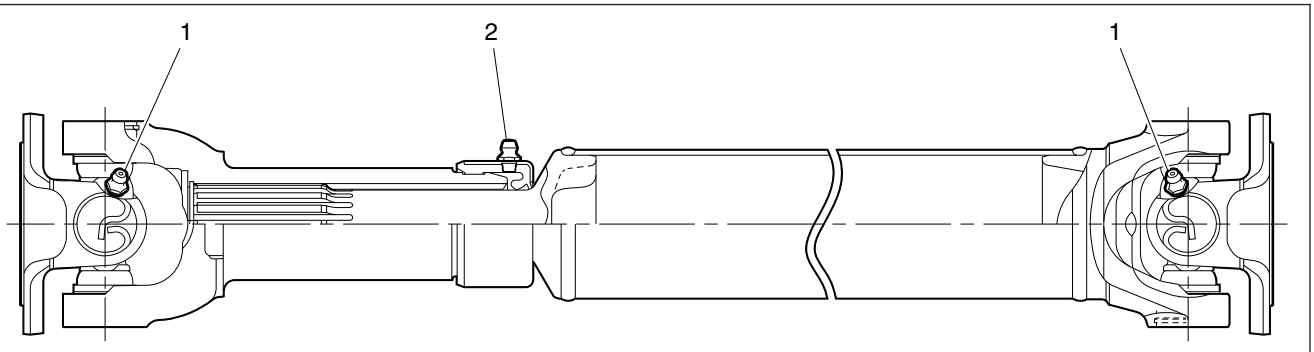
NOTICE

Fresh lubricant must be seen escaping from *both* of the bearing cup seals of each U-joint. If not, the U-joint may fail prematurely.

4. If the bearing will not take grease, replace the U-joint assembly.
5. Check the old grease. If it appears rusty, gritty, or burned, replace the U-joint assembly.
6. Wipe any excess grease from the seals and grease fittings.

Slip-Joint Spline Lubrication

1. Check the slip-joints for spline wear by trying to bend the sleeve-yoke and splined shaft back and forth. If looseness is greater than 0.007 inch (0.18 mm), replace both the sleeve-yoke and the splined shaft.



1. U-Joint Grease Fitting
2. Slip-Joint Grease Fitting

Fig. 4, Slip-Joint and U-Joint Lubricating

2. Wipe all old grease and dirt from the slip-joint grease fitting.
3. Use a hand-type grease gun or a high-pressure gun with a low-pressure adaptor, to lubricate the slip-joint. See **Fig. 4**. Using lithium 12-hydroxy stearate grease (NLGI grade 2, with EP additives and meeting ASTM D4950 LB specifications), lubricate until fresh grease appears at the pressure-relief hole in the yoke plug. Then cover the relief hole with your finger, while continuing to lubricate until fresh grease appears at the slip-joint seal. This ensures complete lubrication of the splines.
4. Wipe any excess grease from the pressure-relief hole, slip-joint seal, and grease fitting.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Transmission Breather Checking	26–01
Transmission Fluid Level Checking	26–03
Transmission Fluid and Filter Changing	26–02

26–01 Transmission Breather Checking

The breather is located at the top left-rear of the transmission main housing. The breather prevents air pressure buildup within the transmission.

Transmission housing breathers must remain unobstructed. A plugged breather could result in pressure build-up, which could cause oil leakage.

If the breather is plugged, clean or replace it. Check more often if the vehicle is operating under very dusty conditions.

⚠ CAUTION

When cleaning the transmission, do not spray steam, water, or cleaning solution directly at the breather. Spraying steam, water, or cleaning solution directly at the breather can force the water or cleaning solution into the transmission and contaminate the transmission fluid.

26–02 Transmission Fluid and Filter Changing

IMPORTANT: For oil and filter change intervals, see the applicable Allison Operator's Manual.

When draining transmission fluid, check for evidence of dirt or water contamination. A small amount of condensation will appear in the fluid during operation.

Water contamination is normally characterized as a milky discoloration of the transmission fluid. Obvious contamination of the transmission fluid indicates a leak between the water and fluid areas of the transmission cooler. Inspect and pressure-test the cooler to confirm the leak; replace leaking transmission coolers.

1000/2100/2200/B210/B220 Series

1. Park the vehicle on a level surface and apply the parking brake.
2. Run the engine until the transmission fluid reaches the operating temperature of 160 to 200°F (71 to 93°C). Shift the transmission to neutral (N) and shut down the engine.

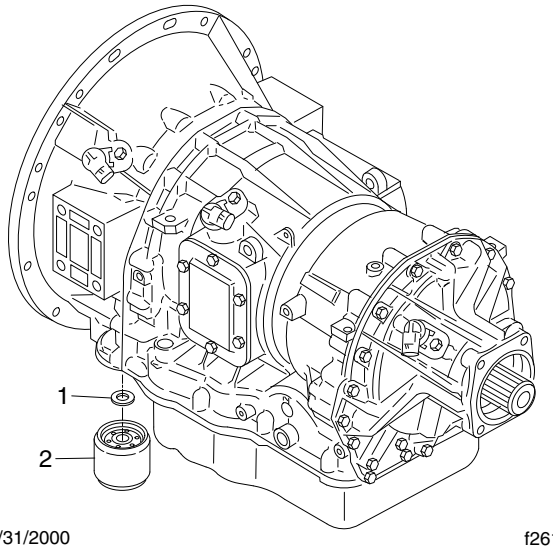
⚠ CAUTION

To prevent dirt from entering the transmission, use only clean containers and fillers for the transmission fluid. Do not use fillers or containers that have been used for water or antifreeze. Dirt, water, or antifreeze could damage the transmission.

3. Clean the area around the drain plug. Place a drain pan under the transmission and remove the drain plug. Examine the fluid while it drains. If only the filter is being changed, do not drain the fluid.

NOTE: A lot of fluid will drain when the filter is removed.

4. Using a standard strap-type filter wrench, remove the filter by turning it counterclockwise. See **Fig. 1**.



1. Magnet
2. External Filter

Fig. 1, 1000/2100/2200/B210/B220 Series Transmission External Filter

5. Remove the magnet from the filter attachment tube or from the top of the filter element.
6. Clean any metal debris from the magnet. Then, install the magnet on the filter attachment tube.
7. Using transmission fluid, lubricate the gasket on the filter.

8. Using your hand, install the filter by turning it clockwise until the filter gasket contacts the converter housing or cooler manifold. Then, turn the filter one more complete turn.
9. Install the drain plug and sealing washer. Tighten the plug 22 to 30 lbf·ft (30 to 40 N·m).
10. Clean the area around the fill tube and remove the dipstick. Using a clean funnel in the fill tube, add transmission fluid. See **Table 1** for approved transmission lubricants, and **Table 2** for lubricant capacities.
11. Check and adjust the fluid level using the procedure under **MOP 26-03, Transmission Fluid Level Checking**.

3000/B300 Series

⚠ CAUTION

To prevent dirt from entering the transmission, use only clean containers and fillers for the transmission fluid. Do not use fillers or containers that have been used for water or antifreeze. Dirt, water, or antifreeze could damage the transmission.

1. Park the vehicle on a level surface and apply the parking brakes.
2. Operate the vehicle until the transmission reaches normal operating temperature: 160 to 200°F (71 to 93°C).
3. Clean the area around the drain plug and the transmission fluid pan. Place a drain pan under the transmission and remove the drain plug. Examine the fluid as it drains. If only the filter is being changed, do not drain the fluid.
4. Remove the 12 mounting bolts (6 each) from the 2 filter covers.

NOTE: A lot of fluid will drain when the filter covers are removed.

5. Remove the filter covers, O-rings, and two square-cut seals from the transmission. See **Fig. 2**.
6. Remove the filters from the bottom of the control module.
7. Lubricate the new O-rings with transmission fluid, and install them on the cover assemblies.

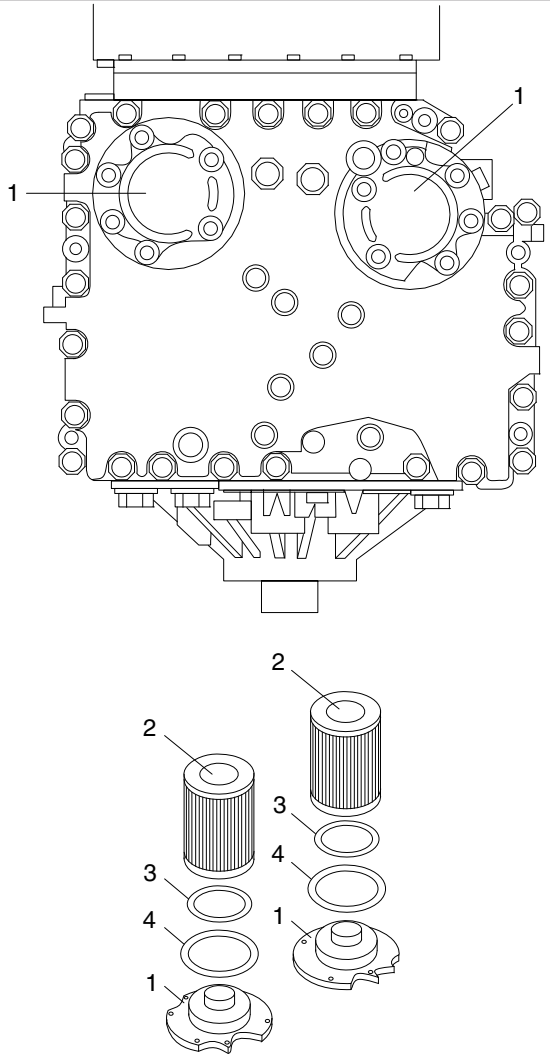


Fig. 2, Allison 3000/B300 Series Transmission Filter Location and Components

8. Install a new square-cut seal on each cover assembly, and install the fluid filter elements on the cover assemblies.

Approved Allison Transmission Lubricants*		
TES-295 Approval Number	**Company**	**Product Brand Name**
AN-051005	ExxonMobil Lubricants and Petroleum Specialties Company	Mobil Delvac Synthetic ATF
AN-011001	Castrol Heavy Duty Lubricants	TranSynd
AN-031002	BP	Autran Syn 295
AN-031003	Cognis Corporation	Emgard 2805
AN-031004	International Truck & Engine Company	Fleetrite Synthetic ATF
AN-071006	John Deere & Company	HD SynTran

* To check the latest Allison approved fluids, go to **www.allisontransmission.com**. Lubricants listed in order of preference. Do not mix types of oil.

Table 1, Approved Allison Transmission Lubricants

Allison Transmission Lubricant Capacities	
Transmission Model	**Fill Capacity:* qt (L)**
1000 Series Standard Sump	10.6 (10)
1000 Series Shallow Sump	7.4 (7)
2100/2200/B210/B220 Series Standard Sump	15 (14)
2100/2200/B210/B220 Series Shallow Sump	13 (12)
3000/B300 Series (4 inch sump)	29 (27)
3000/B300 Series (2 inch sump)	26 (25)

* Quantities listed are approximate. Add the recommended amount of fluid as listed under fill capacity. Do not overfill.

Table 2, Allison Transmission Lubricant Capacities

9. Install the filter and cover assemblies into the filter compartment.
10. Align each cover assembly with the holes in the channel plate sump, and push the cover assemblies in by hand to seat the seals.

CAUTION

Do not use the bolts to draw the filter covers to the sump. This can damage the covers, seals, or sump.

11. Install six bolts in each cover, and tighten the bolts 38 to 44 lbf·ft (51 to 61 N·m).
12. Install a new drain plug O-ring, and install the drain plug. Tighten the drain plug 18 to 24 lbf·ft (25 to 32 N·m).
13. Fill the transmission with fresh transmission fluid and check the fluid level. See **Table 1**. See **Table 2** for lubricant capacities.
14. Check and adjust the fluid level using the procedures under **MOP 26-03, Transmission Fluid Level Checking**.

26–03 Transmission Fluid Level Checking

CAUTION

Operating a transmission with the fluid level higher or lower than recommended can result in transmission damage. Do not overfill the transmission. Overfilling will force fluid out of the case through the main shaft openings.

Do not mix types and brands of fluid, because of possible incompatibility. Do not use fluid additives, friction modifiers, extreme-pressure gear fluids, or multiviscosity lubricants.

Cold Check

Clean all dirt away from around the end of the fluid fill tube before removing the dipstick.

CAUTION

Do not allow foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of transmission parts, make valves stick, and clog passages.

NOTE: After replacing the transmission fluid or changing the filter(s), it is important to check the fluid level cold to determine if the transmission has a sufficient amount of fluid to be safely operated until a hot check can be performed.

1. A cold check may be made when the sump temperature is 160 to 200°F (71 to 93°C).
2. Run the engine for at least one minute to clear the fluid system of air.
3. With the engine running, wipe the dipstick clean and check the fluid level. Any level within the COLD RUN (lower) band is satisfactory for operating the vehicle. See **Fig. 3**. If the level is not within the COLD RUN band, add or drain fluid until it reaches the middle of the COLD RUN band.
4. Perform a hot check at the first opportunity after normal operating temperature, 160 to 200°F (71 to 93°C), is reached.

Hot Check

Recommended Method

With the vehicle on a level surface and the transmission in neutral at operating temperature, perform the steps below.

1. On the transmission shift selector, press the up and down arrow keys simultaneously. See **Fig. 4**.
2. Release the arrow keys and wait for a two-minute countdown.
3. The transmission shift selector display screen will display one of the following messages.
   - OL - OK indicates an acceptable oil level.
   - OL - HI followed by a number indicates the amount that is over-filled.
   - OL - LO followed by a number indicates the amount that is under-filled.
   - OL - 70 indicates that the transmission is not up to operating temperature.

Alternate Method

1. Operate the transmission in a Drive (D) range until normal operating temperature, 160 to 200°F (71 to 93°C), is reached.

NOTE: The fluid must be warm to ensure an accurate check. The fluid level rises as temperature increases.

2. Park the vehicle. Shift to Neutral (N) and set the parking brake. Let the engine run at idle.
3. Wipe the dipstick clean and check the fluid level. A safe operating level is any level within the HOT RUN (upper) band on the dipstick. See **Fig. 3**.
4. If the fluid is not within this range, add or drain fluid as needed to bring the level to the top of the HOT RUN band.

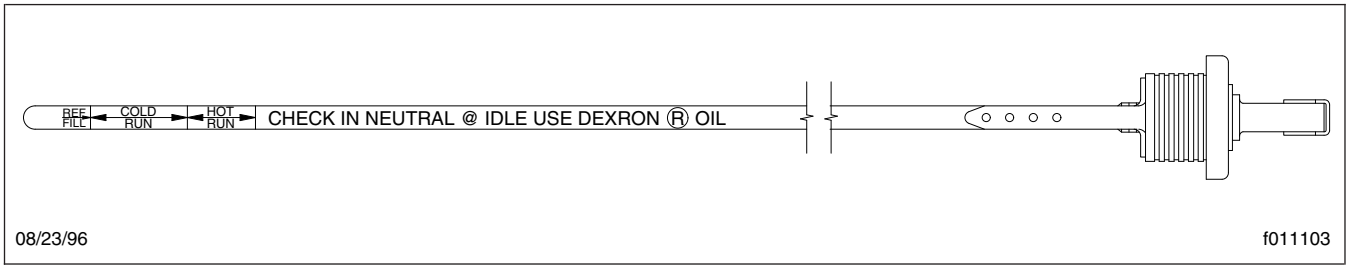
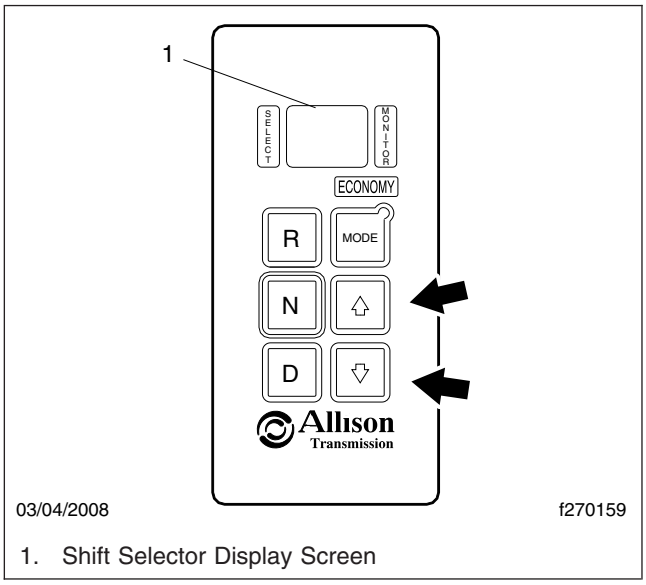


Fig. 3, Dipstick Markings



1. Shift Selector Display Screen

Fig. 4, Transmission Shift Selector

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Frame Fastener Torque Checking	31–01

31–01 Frame Fastener Torque Checking

Because of "bedding in" (or seating), the frame fasteners must be torqued at the recommended intervals. These intervals apply to new vehicles, and to frame fasteners that have been removed and installed again.

⚠ CAUTION

Make sure frame fasteners are properly tightened. Continued vehicle operation with loose fasteners could result in bracket or frame damage.

Typical frame fastener applications include suspension and fuel tank brackets, exhaust and engine supports, and frame crossmembers and gussets.

NOTE: This operation is not intended to be a bolt-by-bolt check of the entire chassis. Do a hand check of the typical frame fasteners. If any fasteners are found loose, tighten them to the correct torque value.

See **Group 00** of the *Shuttle Bus Chassis Workshop Manual* for additional information on fasteners and torque values, or take the vehicle to an authorized Freightliner dealer.

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32–01 Suspension Inspecting, Freightliner Spring

Front and Rear Suspension Spring Assemblies

Inspect the front and rear suspension spring assemblies for pitted, cracked, broken, or abnormally bent leaves and extreme rust. If any of these conditions exist, replace the spring assembly. See **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner dealer.

⚠ WARNING

Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. On front spring assemblies, if cracks or breaks exist in the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in property damage, serious personal injury, or death.

IMPORTANT: On multi-leaf suspensions, closely inspect each component of the leaf spring assemblies, including the brackets, U-bolts, and related parts.

Rear Suspension Spring Brackets

Inspect the forward and rear spring brackets and the wear pads, for wear, cracks, and other damage. If any of these conditions exist, replace the damaged bracket(s) and wear pad(s). See **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner dealer.

⚠ WARNING

Replace worn, cracked, or damaged spring brackets. Failure to do so could result in bracket breakage, possibly leading to loss of vehicle control and resulting in personal injury or property damage.

32–02 Suspension Lubricating, Freightliner Spring

Front Suspension

Wipe all dirt from the grease fittings at the forward spring pin and the spring shackle pins; then apply multipurpose chassis grease with a pressure gun until the old grease is forced out.

Rear Suspension

Lubricate the spring pin by applying multipurpose chassis grease at the grease fitting. See **Fig. 1**. Lubricate with a grease gun until grease appears at the base of the fitting.

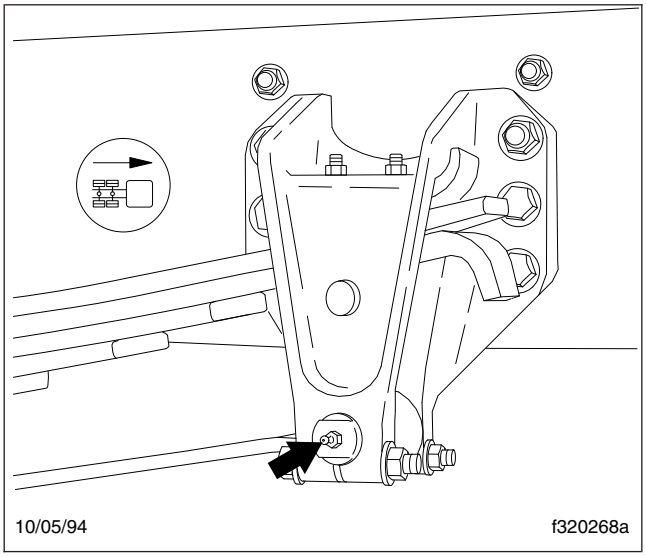


Fig. 1, Forward Spring Bracket Spring Pin Grease Fitting

32–03 U-Bolt Torque Checking, Freightliner Spring

Check the U-bolt torque of both the front and rear axles.

NOTICE

Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

In a diagonal pattern, tighten all 5/8–18 U-bolt nuts 205 lbf·ft (278 N·m); tighten all 3/4–16 U-bolt nuts 300 lbf·ft (407 N·m); and tighten all 7/8–14 U-bolt nuts 460 lbf·f (624 N·m).

32–04 Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)

NOTICE

Continued use with loose fasteners could result in bracket and frame damage.

Torque the fasteners that attach the forward and rear spring brackets and equalizer brackets to the frame rail. Tighten 1/2–13 locknuts with hardened washers 85 lbf·ft (115 N·m). Tighten 5/8–11 locknuts with hardened washers 170 lbf·ft (230 N·m). Tighten 3/4–10 locknuts with hardened washers 305 lbf·ft (414 N·m).

See **Group 00** for other frame fastener torque values.

32–05 Fastener Torque Checking, Freightliner AirLiner

Tighten all suspension fasteners to the torque values in **Table 1**. Also, tighten all suspension air line fittings and air lines.

32–06 Component Clearance Checking, Freightliner AirLiner

NOTICE

Failure to relocate obstructing parts could result in damage to the air spring.

Check that the air line support brackets are positioned so that air lines do not rub against anything. Reposition any configurations that could contact and result in friction and wear. There must be at least 1 inch (25 mm) clearance around the rubber air spring when inflated. If the clearance is less than 1 inch (25 mm), relocate the obstructing parts.

Torque Values for Freightliner AirLiner Suspensions		
Description	**Size**	**Torque: lbf·ft (N·m)**
Leveling Valve Adjustment Nut	1/4–20	5 (7)
Leveling Valve Mounting Bolt Nuts	5/16–18	14 (19)
Air Spring Upper Mounting Locknuts	3/4–16	45 (61)
	1/2–13	23 (31)
Air Spring Lower Mounting Locknuts	1/2–13	55 (75)
Leaf Spring Mounting Eye Bolt Locknuts	3/4–16	270 (365)
Shock Absorber Upper Bracket Mounting Locknuts	5/8–11	125 (170)
Air Spring Upper Mounting Bracket	5/8–11	125 (170)
Spring Hanger Mounting Locknuts	3/4–10	210 (285)
Torque Arm Rod Nut	5/8–11	136 (185)

Table 1, Torque Values for Freightliner AirLiner Suspensions

32–07 Component Inspecting and Operation Checking, Freightliner AirLiner

⚠ WARNING

Inspect the components and check their operation as described below. Failure to perform these inspections and checks could result in separation of worn suspension components and loss of vehicle control, possibly causing personal injury and property damage.

1. Chock the front tires. Raise the rear of the vehicle so that the tires just clear the ground and so that the suspension is fully extended. Place safety stands under the vehicle frame.
2. Squeeze all air springs to check for complete deflation. If any air springs remain partially or fully inflated, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
3. Inspect each air spring for wear at its connection to the pedestal. Replace any worn air springs; for instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
4. Check the axle connection welds (beam-seat to equalizing-beam) and axle-adapter to axle for cracks. If welds are cracked, grind them out and reweld the parts.
5. Move the axle up and down while checking for signs of looseness due to worn parts at the front pivot connections. Replace any worn parts by following the procedures in **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
6. Inspect the shock absorbers for oil leaks and worn rubber bushings. Replace the shock absorbers and/or rubber bushings if wear or damage is noted. For instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
7. Remove the safety stands and lower the rear of the vehicle to the ground. Run the engine until air pressure of at least 100 psi (689 kPa) is maintained throughout the system.
8. Check that all air springs are inflated. If the air springs do not inflate, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for possible causes and corrections, or take the vehicle to an authorized Freightliner dealer.

32–08 U-Bolt Torque Checking, Freightliner AirLiner

NOTICE

Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

In a diagonal pattern, tighten all 5/8–18 U-bolt nuts 205 lbf·ft (278 N·m); tighten all 3/4–16 U-bolt nuts 300 lbf·ft (407 N·m); and tighten all 7/8–14 U-bolt nuts 460 lbf·ft (624 N·m).

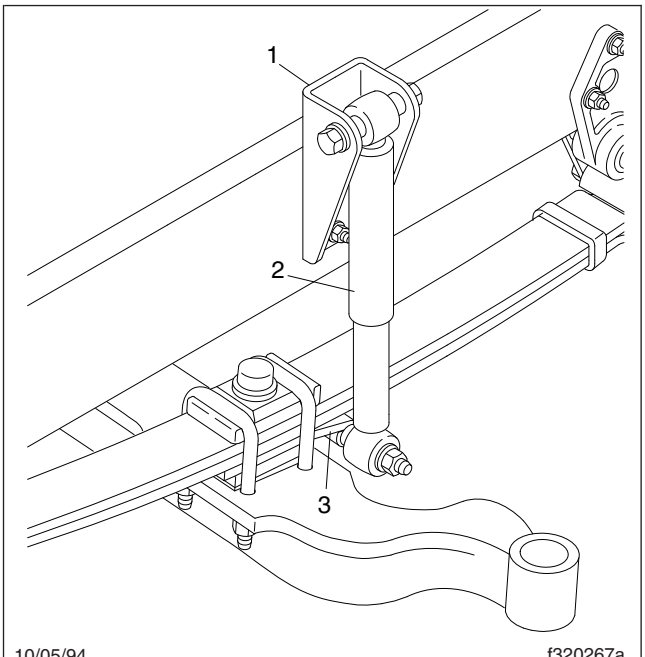
32–09 Shock Absorber Checking, Freightliner Spring

Make sure that the shock absorber brackets are tight, and that the shock absorber is not striking or rubbing on the frame or some other part of the chassis. See **Fig. 2**. Check the rubber mounting bushings and replace if worn. Inspect the shock absorber for oil leakage.

If the shock absorber is worn or damaged, replace it with a new one.

32–10 Torque Arm Bushing Checking, Freightliner AirLiner

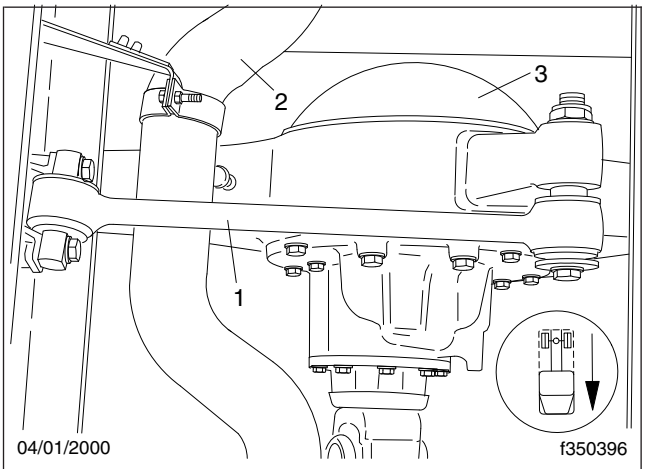
1. Without detaching the torque arms, attempt to move (by hand) each of the rod ends up, down, in, and out. See **Fig. 3**. If there is any movement, replace the torque arm.
2. Inspect the rubber bushing ends. Replace the torque arm if there are gaps between the rubber bushing and the pin or the outer steel sleeve. If either bushing end contacts a torque arm pin mounting bolt, if there are cracks in the bushing, or if part of the rubber bushing extends beyond



1. Upper Mounting Bracket
2. Shock Absorber
3. Lower Mounting Bracket

Fig. 2, Shock Absorber Installation (front suspension shown)

the outside circumference of the outer bushing sleeve, replace the torque arm.



1. Torque Arm
2. Exhaust Pipe
3. Rear Axle Housing

Fig. 3, Torque Arm

IMPORTANT: Be sure to follow the maintenance schedule for checking the torque of the control rod fasteners; see **Table 1** for control rod torque values.

32–11 Suspension Inspecting, Neway

⚠ WARNING

Inspect the components and check their operation as described below. Failure to perform these inspections and checks could result in separation of worn suspension components and loss of vehicle control, possibly causing personal injury or death, or property damage.

1. Chock the front or the rear tires. Working at the front of the vehicle or at the rear of the vehicle, raise the vehicle so that the tires just clear the ground and the suspension is fully extended. Place safety stands under the vehicle frame.
2. Squeeze all air springs to check for complete deflation. See **Fig. 4** and **Fig. 5**. If any air springs remain partially or fully inflated, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Inspect the air springs for cracks, tears, or other damage.
3. Inspect each air spring for wear at the pedestal connection. Inspect for leaks at the upper and lower pedestal connections using a soapy solution. Replace any worn air springs; for instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
4. Inspect the bolts and nuts at the pivot connections, the transverse beam connections, and the axle connections to ensure they are tightened to the correct torque specification.
5. Check all of the other suspension components for any sign of damage, looseness, wear, or cracks. Replace worn or damaged parts. See **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

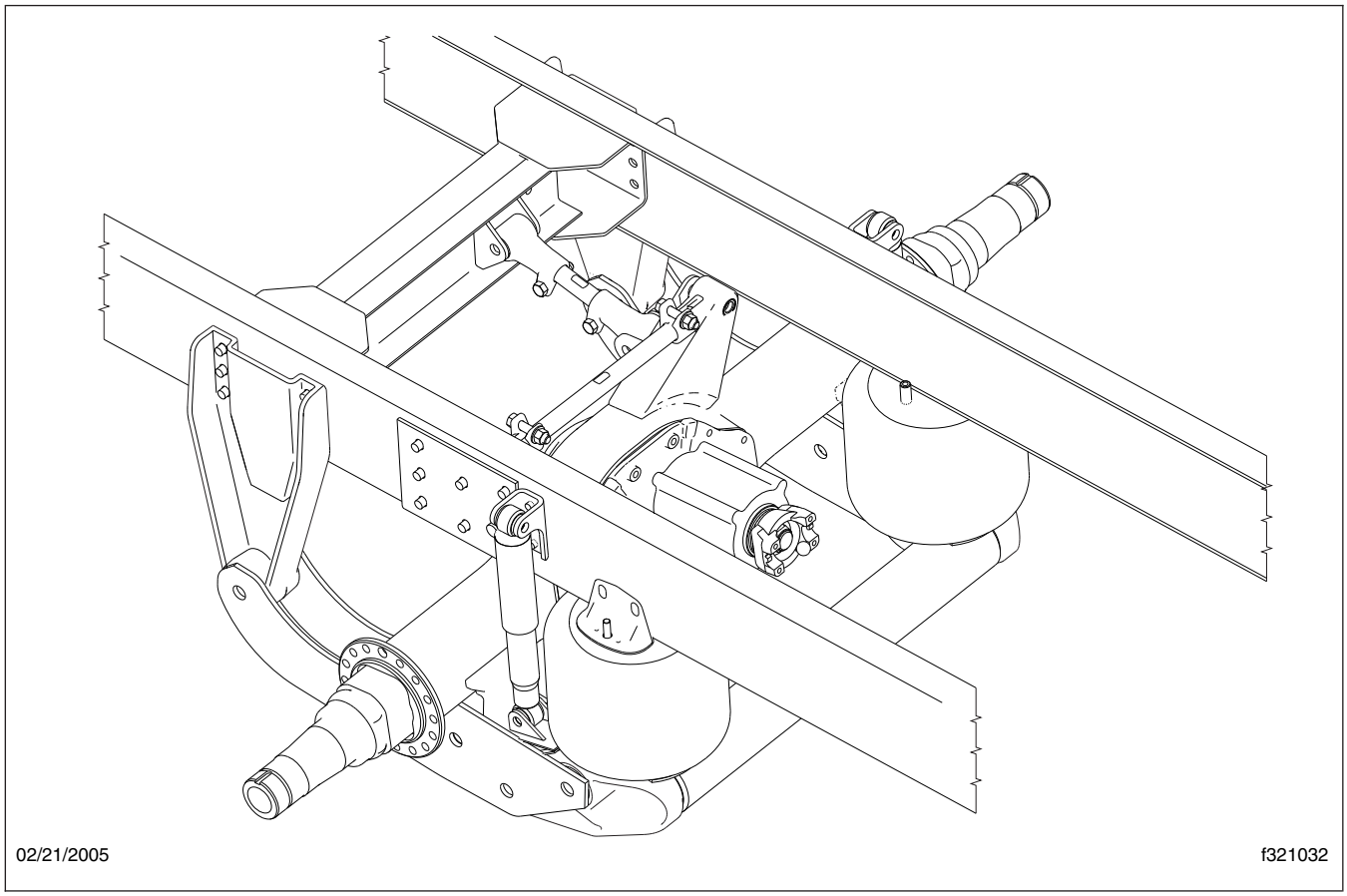


Fig. 4, Holland® Neway® ADL 120/123 Suspension

6. Inspect for cracked welds. If cracks are found, contact Neway immediately for further instructions.
7. Inspect the torque rod and track bar pivot bushings for excessive wear. Replace worn or damaged bushings. See **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
8. Move the axle up and down while checking for signs of looseness due to worn parts at the front pivot connections. Replace any worn parts by following the procedures in **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
9. Check for leaks on the height control valves by applying a soapy solution, then watching for bubbles at all air connections and fittings.
10. Inspect the shock absorbers for oil leaks and worn rubber bushings. Replace the shock absorbers and/or rubber bushings if wear or damage is noted. For instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
11. Remove the safety stands and lower the vehicle to the ground. Run the engine until air pressure of at least 100 psi (689 kPa) is maintained throughout the system.

IMPORTANT: Repeat this check at both ends of the vehicle.

12. Check that all air springs are inflated. If the air springs do not inflate, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for possible causes and corrections, or take the vehicle to an authorized Freightliner dealer.

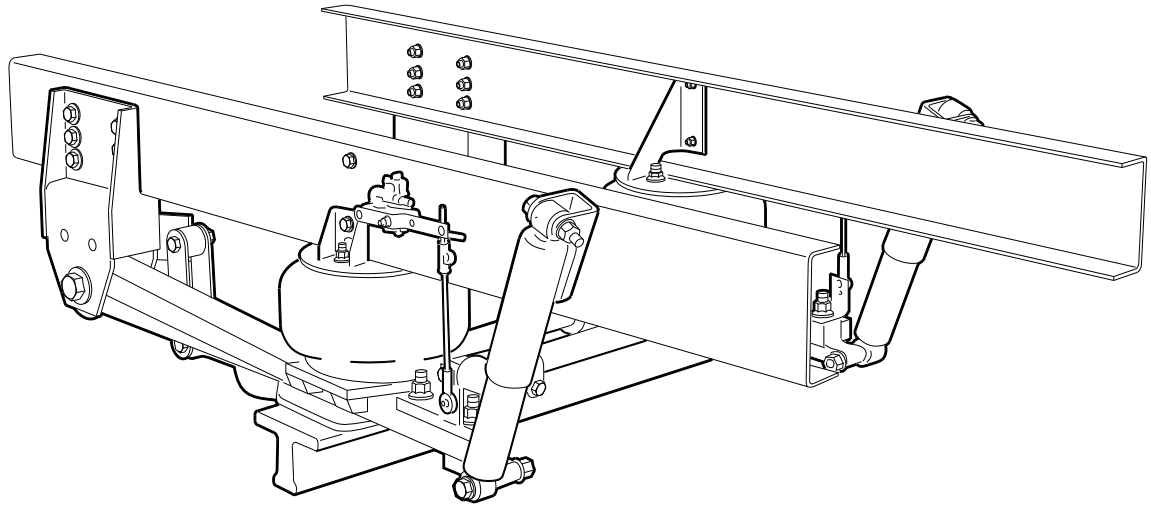


Fig. 5, Holland® AS-120 Suspension

32–12 ZF IFS Lubricating

IMPORTANT: Do not raise the vehicle by placing a jack under the control arm(s). The weight of the vehicle could damage the control arms and cause alignment issues. See **Fig. 6** for correct jack placement.

1. Chock the rear tires and apply the parking brake. Raise the front of the vehicle with a jack so the tires just clear the ground and the suspension is fully extended. Place safety stands under the vehicle frame.

⚠ WARNING

Never work around or under a vehicle that is supported only by a jack. Always support the vehicle with safety stands. Jacks can slip, causing the vehicle to fall, which could result in serious injury or death.

2. Remove the wheel hub. See **Group 33** of the *Shuttle Bus Chassis Workshop Manual* for wheel bearing service procedures, or take the vehicle to an authorized Freightliner dealer.
3. Lubricate the steering knuckle/control arm at indicated maintenance intervals. Use only an NLGI Grade 2 lithium-based grease, multipurpose grease, or mineral oil on the lubricating points. See **Fig. 7** and **Fig. 8**.

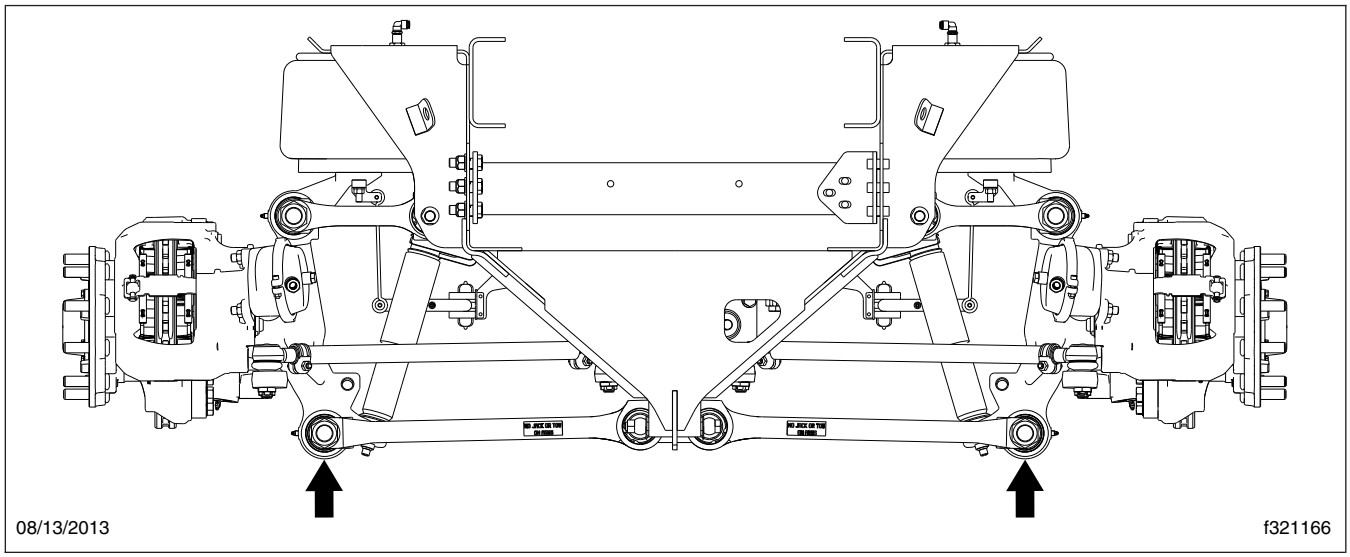
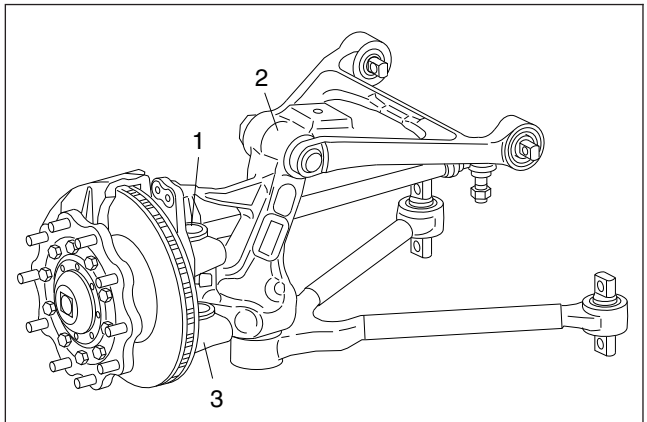
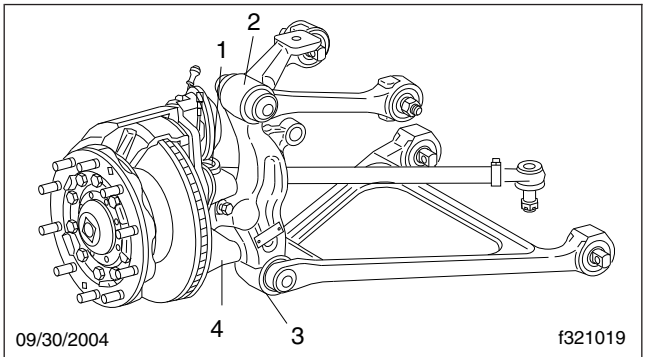


Fig. 6, ZF IFS Jack Placement



1. Steering Knuckle Bearing Grease Fitting (upper)
2. Steering Knuckle
3. Steering Knuckle Bearing Grease Fitting (lower)

Fig. 7, Pressure Grease Fitting Positions, RL-75E



1. Steering Knuckle Bearing Grease Fitting (upper)
2. Control Arm Grease Fitting (upper)
3. Control Arm Grease Fitting (lower)
4. Steering Knuckle Bearing Grease Fitting (lower)

Fig. 8, Pressure Grease Fitting Positions, RL-75EM

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33–01 Knuckle Pin Lubricating

NOTICE

Use regulated pressure when lubricating the knuckle assemblies, otherwise damage could result to the knuckle caps.

Detroit™ Axles

On the front axle, grease fittings are on the top and bottom caps of each knuckle.

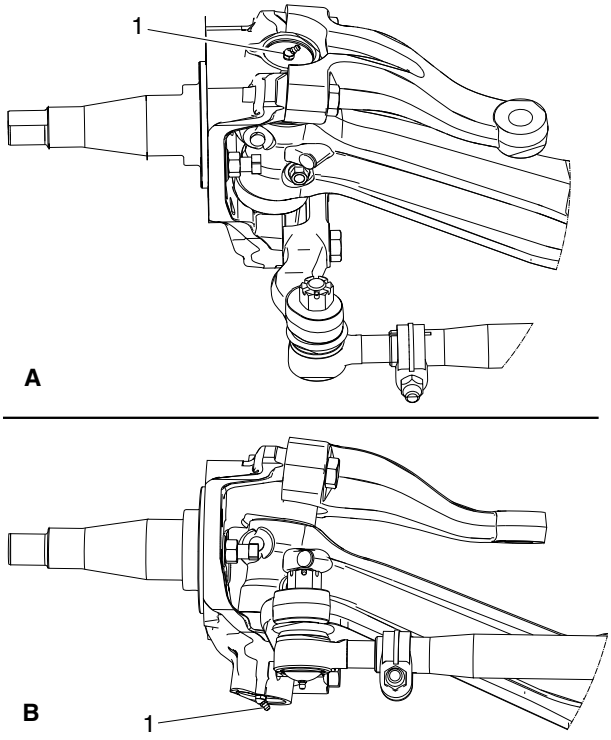
1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires. When lubricating upper and lower knuckle assemblies, do not raise the front axle.
2. Wipe the grease fittings clean.
3. Apply multipurpose chassis grease, NLGI Grade 1 (6% 12-hydroxy lithium stearate grease) or NLGI Grade 2 (8% 12-hydroxy lithium stearate grease), until new grease is seen at the junctions of the axle beam and knuckles. For locations of grease fittings, see **Fig. 1**; for grease exit points, see **Fig. 2**.

Meritor Axles

Hold a pressure gun on each fitting until fresh grease appears. See **Fig. 3**. This will ensure that all of the old contaminated grease has been forced out. It is not necessary to exceed 4000 psi (27 560 kPa). The best distribution of new lubricant and the best purging of old lubricant occurs when about 4000 psi (27 560 kPa) pressure is applied at the grease gun nozzle. Using a 40 to 1 booster, the air should be limited to 100 psi (689 kPa); using a 50 to 1 booster, the air should be limited to 80 psi (551 kPa). Higher or lower pressures are not recommended.

When lubricating Meritor knuckle pin bushings for Initial Maintenance, raise the front axle until the front tires are off of the ground. Wipe the lube fittings clean, and slowly feed multipurpose chassis grease (NLGI grade 1 or 2) into each bushing area while turning the wheels from extreme right to left and back again (lock-to-lock). This will eliminate small air pockets and improve grease distribution.

Lower the front axle so that the tires are on the ground, and regrease both top and bottom bushings



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A Upper View, LH Side B Lower View, LH Side
1. Grease Fitting

Fig. 1, Grease Fittings, Detroit Axles

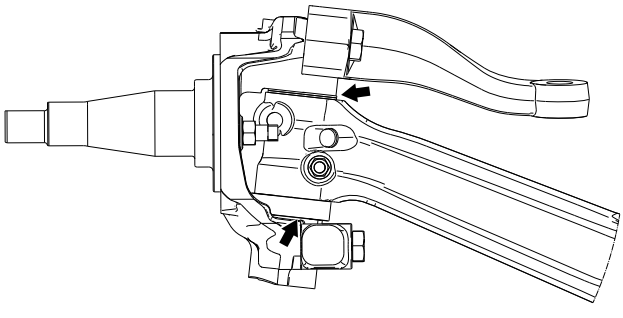

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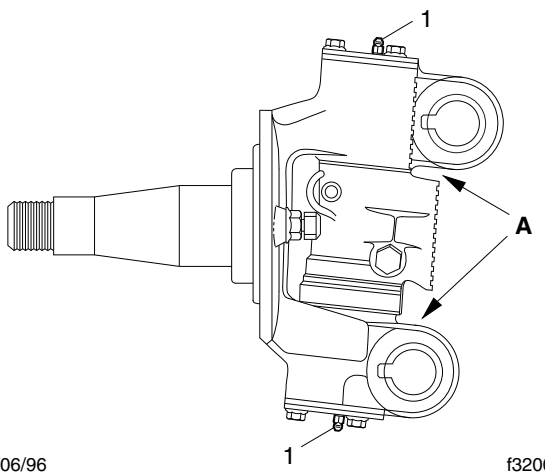
Fig. 2, Knuckle Pin Grease Exit Points, Detroit Axles

until new grease is seen at the seal on the bushing opposite the fittings.

NOTE: The grease seal will accept the grease pressure without damaging the seal, and is designed to have grease pumped out through it



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Pump lubricant into each grease fitting until fresh grease comes out at A.

1. Grease Fitting

Fig. 3, Meritor Axle Grease Fittings

during lubrication. Even if grease leaks out around the top or bottom plate, continue pumping until new grease is seen at the seal on the bushing opposite the grease fitting.

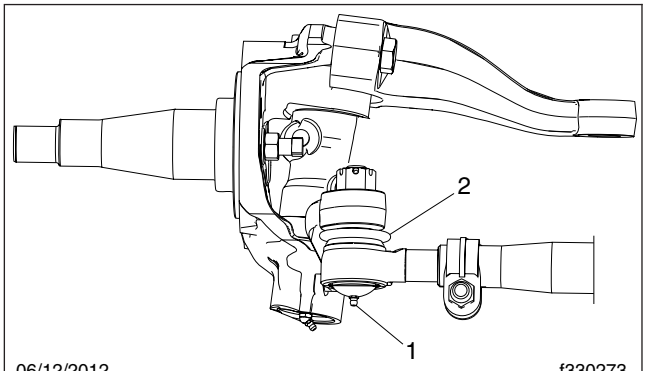
When lubricating knuckle pin bushings at M1 through M3, do not raise the front axle. Wipe the lube fittings clean, and apply multipurpose chassis grease until new grease is seen at the grease seal on the bushing opposite the fittings.

33–02 Tie-Rod End Lubricating

For any Detroit or Meritor axle that requires lubrication of the tie-rod ends, wipe the grease fittings clean, then pump multipurpose chassis grease, NLGI Grade 1 (6% 12-hydroxy lithium stearate grease) or NLGI Grade 2 (8% 12-hydroxy lithium stearate grease), into the tie-rod ends until all used grease is forced out and fresh grease is seen at the ball stud neck. See **Fig. 4**.

33–03 Tie-Rod End Inspecting

IMPORTANT: DOT roadside tie-rod assembly replacement criteria specifies that if tie-rod endplay is 1/8 inch (3 mm) or greater, measured on the road, the vehicle must be taken out of service immediately. If there is endplay, but it is less than 1/8 inch (3 mm), the vehicle does not have to be taken out of service but a major out-of-service inspection and maintenance must be scheduled as soon as possible.



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NOTE: No grease should emit from the tie-rod boot. If grease emits from the tie-rod boot, the boot is damaged.

1. Grease Fitting 2. Boot

Fig. 4, Grease Fitting and Boot (Detroit axle shown)

1. Check the tie-rod ends for looseness.
   - 1.1 Park the vehicle so that the front wheels are in the "straight ahead" position.
   - 1.2 Chock the front and rear tires.
   - 1.3 Remove dirt and grease from the seals or boots on the tie-rod ends. Visually inspect the tie-rod ends. Replace the tie-rod ends if the seals or boots are cracked, worn, or damaged.

   IMPORTANT: Check the tie-rod endplay by hand. Do not use a pry bar. If a pry bar is used, the dial indicator will not read correctly.

   NOTE: For accurate readings, use a dial indicator with a "contour-type" base.

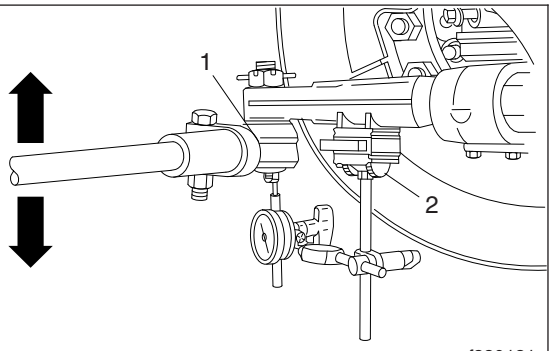
   - 1.4 Position the dial indicator so that the base of the indicator is on the bottom of the tie-rod arm. Place the tip of the indicator on the bottom of the tie-rod end at the center of the ball stud on the surface that is most flat, as shown in **Fig. 5**.
   - 1.5 Set the dial indicator to zero.

1.6 By hand, move the tie-rod end and the cross tube assembly up and down. If the dial indicator reads more than 0.060 inch (1.52 mm), replace the tie-rod end at once.

1.7 Install the dial indicator as described above, and repeat this procedure on the opposite tie-rod end.

2. Inspect the tie-rod ends.

2.1 The threaded portion of the tie-rod end assembly must be inserted all the way into the cross-tube split, for adequate clamping. See **Fig. 6**. Replace the parts if this cannot be done. For instructions, see the axle manufacturer's service manual.



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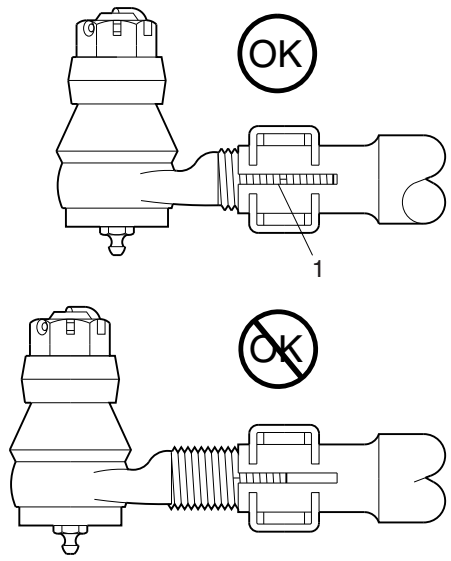
NOTE: If the reading is more than 0.060 inch (1.52 mm) when moving the tie-rod end and cross tube assembly up and down, replace the tie-rod end.

1. Tie-Rod End
2. Dial Indicator with "Contour-Type" Base

Fig. 5, Measuring Tie-Rod End Looseness

2.2 Check the tie-rod end nut and clamp nut torques. For Detroit axles, see **Table 1** for tie-rod end nut torque specifications and **Table 2** for tie-rod end clamp nut torque specifications.

For Meritor axles, tighten the tie-rod end nut 100 lbf·ft (136 N·m), and tighten the clamp nut 40 to 55 lbf·ft (54 to 75 N·m).



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IMPORTANT: The tie-rod end threads must be visible throughout the entire length of the split.

NOTE: Pinch bolt not shown to provide clarity.

1. Cross-Tube Split

Fig. 6, Tie-Rod End Adjustment

Detroit Axle Tie-Rod End Nut	
Thread	**Torque: lbf·ft (N·m)**
5/8–16	60 to 115 (81 to 156)
5/8–18	60 to 115 (81 to 156)
3/4–16	90 to 170 (122 to 230)
7/8–14	160 to 300 (217 to 407)

Table 1, Detroit Axle Tie-Rod End Nut

Detroit Axle Tie-Rod End Clamp Nut	
Thread	**Torque: lbf·ft (N·m)**
1/2–13	35 to 45 (47 to 61)
5/8–11	40 to 60 (54 to 81)
5/8–18	50 to 64 (73 to 87)
3/4–10	155 to 175 (210 to 237)

Table 2, Detroit Axle Tie-Rod End Clamp Nut

33–04 Wheel Alignment Checking, Front Axle

See **Group 33** of the *Shuttle Bus Chassis Workshop Manual* for wheel alignment checking and adjusting procedures, or take the vehicle to an authorized Freightliner dealer.

33–05 Oil-Filled Hubs Oil Level Checking

⚠ WARNING

Be careful not to overfill the hubs. Overfilling may cause oil to be forced out of the hubs and to contaminate the brake linings and other brake components. This could result in loss of vehicle control and lead to personal injury and property damage.

1. With the vehicle on a level surface, rotate the front wheels and allow the oil in the hubs to settle.
2. Chock the tires.

IMPORTANT: The oil level should be at, or no more than 1/4 inch (6 mm) above, the level indicators on the hub caps.

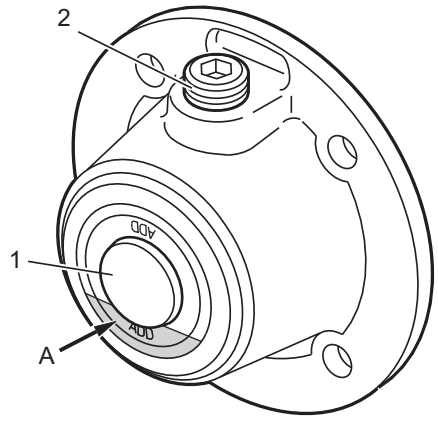
3. If necessary, remove the filler caps (in the ends of the hub caps) and add enough oil (80/90 hypoid gear oil) to bring the oil to the proper level.
4. Rotate the wheels, allow the oil to settle, and check the levels again.
5. Install the filler caps securely.
6. Remove the chocks from the tires.

33–06 Oil-Filled Hubs Oil Changing

⚠ WARNING

Be careful not to overfill the hubs. Overfilling may cause oil to be forced out of the hubs and to contaminate the brake linings and other brake components. This could result in loss of vehicle control and lead to personal injury and property damage.

1. With the vehicle on a level surface, rotate the front wheels so that the front hub drain plugs are positioned downward.
2. Chock the tires.
3. Place suitable containers under the hubs, remove the filler caps (in the ends of the hub caps) and the drain plugs, and allow the hubs to drain completely. See **Fig. 7**.



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A. Hub Cavity Full
1. Fill Plug/Magnetic Drain
2. Drain Plug

Fig. 7, Oil-Filled Hub Cap

4. Install the drain plugs and tighten 25 lbf·in (282 N·cm).
5. Add approximately 1 to 1-1/2 pints (0.5 to 0.7 L) of oil (80/90 hypoid gear oil) to each hub.
6. Rotate the wheels, allow the oil to settle, and check the levels.

IMPORTANT: Fill the hubs to the level indicators on the hub caps, or to no more than 1/4 inch (6 mm) above the indicators. See **Fig. 7**.

7. Install the filler caps securely.
8. Remove the chocks from the tires.

33–07 Wheel End Inspection

IMPORTANT: For ZF IFS axles, ZF recommends that all grease fittings be lubricated once

a year, preferably before periods of inactivity. The wheel hub should be disassembled, inspected, and the wheel bearings repacked every 1,000,000 miles (1 609 000 km).

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.

⚠ WARNING

Never work around or under a vehicle that is supported only by a jack. Always support the vehicle with safety stands. Jacks can slip, causing the vehicle to fall, which could result in serious injury or death.

2. Raise the front of the vehicle and support it with safety stands.
3. Remove the front wheel and tire assemblies. For instructions, see **Group 40** of the *Shuttle Bus Workshop Manual*.
4. Remove the brake drum. For more information, see **Group 33** of the *Shuttle Bus Workshop Manual*.
5. Check for loose, damaged, or missing fasteners and hubcaps.
6. Check for lubricant around the hub cap and wheel. If lubricant is present, investigate the cause and take corrective action.
7. Check for lubricant around the hub, brake hardware, and brake shoes (if installed). If lubricant is present, check the oil seal and replace it as necessary. For instructions, see **Section 33.03** of the *Shuttle Bus Workshop Manual*.
8. Inspect the lubricant for discoloration. Under normal conditions, the lubricant will darken; a white or milky appearance indicates water contamination. If the lubricant is discolored, service the wheel end. See the *Shuttle Bus Workshop Manual* and manufacturer literature for procedures.

IMPORTANT: Do not mix different types of lubricants.

9. Inspect the lubricant for the presence of foreign matter. Use a magnet to detect any metallic materials present in the lubricant. If the lubricant is contaminated, service the hub. See the *Shuttle Bus Workshop Manual* and manufacturer literature for procedures.
10. Rotate the hub and check for free, smooth, and quiet rotation. If rotation is hampered, service the hub immediately. See the *Shuttle Bus Workshop Manual* and manufacturer literature for procedures.

⚠ WARNING

Correct wheel-bearing end play is crucial to the safe and sound operation of the vehicle. If the end play is not correct, the wheel bearings could fail and cause the loss of the wheel and hub assembly and result in an accident causing property damage, serious injury, or death. Use a dial indicator to measure the end play.

IMPORTANT: Do not measure the wheel bearing end play with the wheel mounted on the hub; you cannot accurately measure or adjust bearing end play with the wheel mounted on the hub. Also, ensure that the brakes are not applied so that that drum and hub can move freely.

11. Using a dial indicator, measure the end play as follows.
    - 11.1 Attach the magnetic base of a dial indicator to the end of the spindle, and place the measuring end of the indicator against the hub cap mounting flange. See **Fig. 8**.

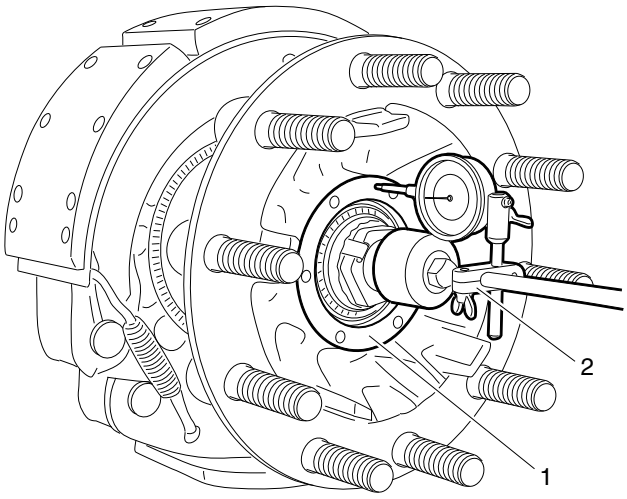
    IMPORTANT: Maintain continual pressure on the hub until you have taken both the inboard and outboard measurements. If you release the hub, an accurate measurement is not possible.

    - 11.2 To seat the bearings, grip the hub at the three o'clock and nine o'clock positions, and push inward while oscillating it approximately 45 degrees. Maintain pressure on the hub, note the inboard measurement, and then pull the hub outward while oscillating it as before. Maintain pressure on the hub, and note the outboard measurement. See **Fig. 9**.

      The end play is the difference between the two measurements. The end play limit for PreSet hubs is 0.006 inch (0.15 mm); for non-PreSet hubs the acceptable range

is 0.001 to 0.005 inch (0.03 to 0.13 mm) inclusive.

If the end play does not exceed the limit and no other problems were found in the previous steps, no additional service is necessary. If the end play exceeds the limit, service the hub. See the *Shuttle Bus Workshop Manual* and manufacturer literature for procedures.



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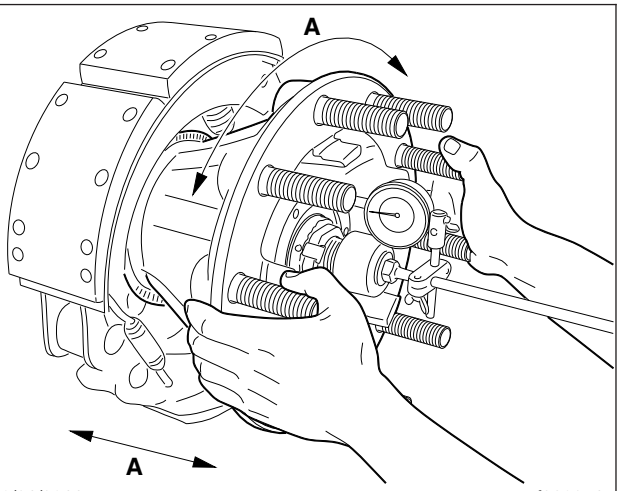
1. Hub Cap Mounting Flange
2. Dial Indicator (with magnetic base)

Fig. 8, Dial Indicator Setup



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A. Pull and push the hub while oscillating it.

Fig. 9, Measuring End Play

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Axle Breather Checking	35–03
Axle Lubricant Changing and Magnetic Plug Cleaning	35–02
Axle Lubricant Level Checking	35–01

35–01 Axle Lubricant Level Checking

NOTICE

Failure to keep the rear axle filled to the proper level with the recommended lubricant can result in rear axle damage.

NOTE: If the vehicle is exposed to water deep enough to cover the hubs, disassemble and inspect them for water damage and/or contamination. See **Group 35** of the *Shuttle Bus Chassis Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner dealer.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. If the vehicle has just been driven, allow a few minutes for the lubricant to settle.
3. Clean the fill plug and the area surrounding the fill plug on the side of the axle carrier. Remove the plug. Check lubricant level when the axle is cold, or near room temperature. See **Fig. 1** for a Detroit axle, or **Fig. 2** or **Fig. 3** for a Meritor axle.

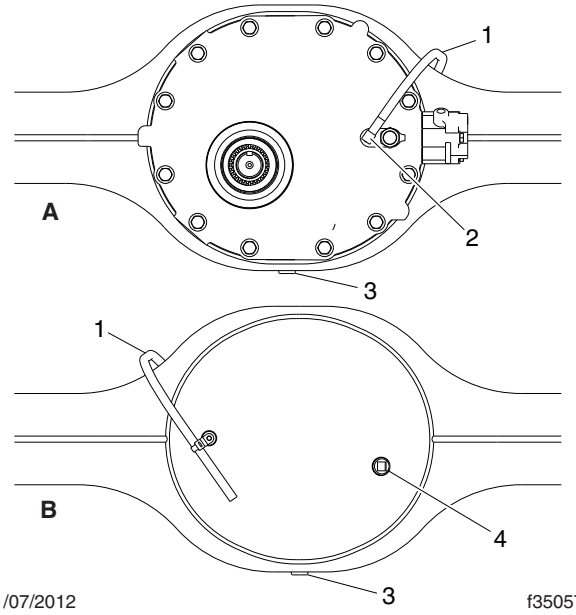
NOTE: Some axles have a small tapped and plugged hole located near and below the housing oil fill hole. This smaller hole is for the lubricant temperature sensor only, and must not be used as a fill or level hole.

4. Check that the lubricant is level with the bottom of the fill hole. See **Fig. 4**. If low, check for oil leaks, and correct as needed. Add oil to the level of the fill plug. For a Detroit axle, use a lubricant recommended in **Table 1**.

   For a Meritor axle, add Castrol TranSynd synthetic automatic transmission oil.

IMPORTANT: A lubricant level close enough to be seen or touched is not sufficient. It must be level with the bottom of the fill hole.

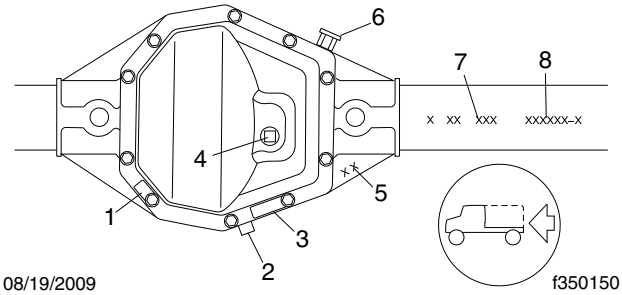
5. Install the oil fill plug and tighten it 30 lbf·ft (41 N·m) for a Detroit axle or 35 lbf·ft (47 N·m) for a Meritor axle.



NOTE: Engine-front configuration shown; engine-rear configuration is similar.

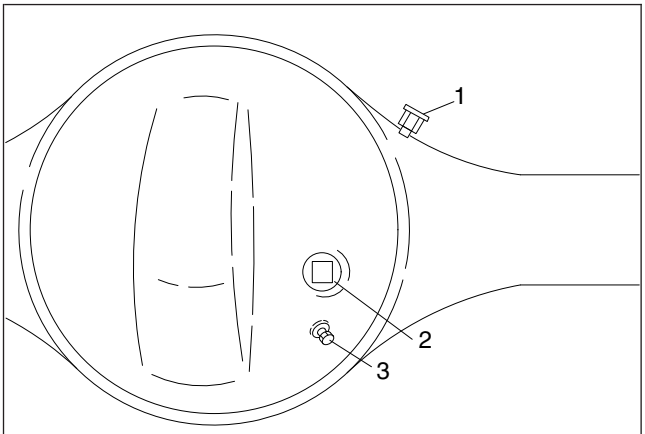
A. Front View
B. Rear View
1. Breather Hose
2. Axle Housing Breather
3. Oil Drain Plug
4. Oil Fill Plug

Fig. 1, Component Locations, Detroit Axles



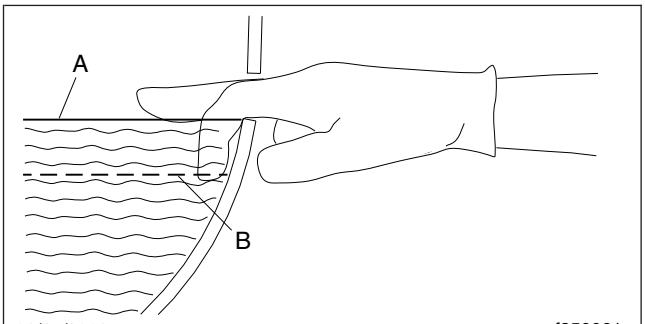
1. Ratio Tag
2. Drain Plug
3. Limited Slip Lubrication Tag
4. Filler Plug
5. Model Number
6. Axle Housing Breather
7. Manufacturing Date
8. Part Number

Fig. 2, Meritor Rear Axle Differential, MB Shuttle Bus



1. Axle Housing Breather
2. Fill Plug
3. Temperature Indicator Plug

Fig. 3, Meritor Axle Housing (typical), XB Shuttle Bus



A. Correct (lube level at bottom of fill hole)
B. Incorrect (lube level below fill hole)

Fig. 4, Axle Lubricant Level Inspection

Drive Axle Recommended Lubricant*†		
Recommended Lubricant Type	**Ambient Temperature**	**Lubricant SAE Viscosity Grade**
Hypoid Gear Oil API Service Classification GL–5	10°F (–12.2°C) and up‡	85W–140
	–15°F (–26.1°C) and up‡	80W–90
	–40°F (–40°C) and up‡	75W–90
	–40°F (–40°C) to 35°F 2°C)	75W
	–40°F (–40°C) and up‡	75W–140

Drive Axle Recommended Lubricant*†		
Recommended Lubricant Type	**Ambient Temperature**	**Lubricant SAE Viscosity Grade**
Synthetic Gear Oil	–40°F (–40°C) and up‡	75W–90
	–40°F (–40°C) and up‡	75W–140

* Lubricant used in Detroit rear axles must meet the requirements of the API GL-5 standard. Recommended lubricants meet Mercedes-Benz specification 235.8 (synthetic) or 235.20 (mineral); see http://bevo.mercedes-benz.com for product names.

† Detroit rear axles do not require the use of friction modifiers.

‡ There is no upper limit on the ambient temperature, but axle sump temperature must never exceed 250°F (121°C).

Table 1, Drive Axle Recommended Lubricant, Detroit Axles

35–02 Axle Lubricant Changing and Magnetic Plug Cleaning

A regular schedule for changing the axle lubricant in a particular vehicle and operation can be accurately determined by analyzing oil samples taken from the axle at specified intervals or mileages. Lubricant suppliers frequently make their laboratory facilities available for determining the useful life of their product under actual service conditions. The final schedule that is recommended may, for economic reasons, be correlated with lubricant changes that are governed by climatic conditions and magnetic plug maintenance. Change lubricant type and viscosity as climatic temperatures demand, regardless of vehicle mileage or established change schedule.

The normal operating temperature of compounded lubricants during the summer season is about 160 to 220°F (71 to 104°C). The chemicals and additives that give these lubricants increased load-carrying capacity, oxidize faster at temperatures above 220°F (104°C), contributing to more rapid lubricant deterioration. For this reason, lubricants of this type, that operate continuously at high temperatures, must be changed more frequently.

NOTICE

Failure to change the axle lubricant at more frequent intervals, when adverse operating conditions require, could result in axle damage.

NOTE: A normal oil change does not include the hubs.

Detroit Axle

Axle Draining

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Clean the fill plug and the area around it. Remove the plug from the oil fill hole. See **Fig. 1**.

⚠ CAUTION

Be careful when draining the axle oil. It may be very hot, and could cause personal injury if it contacts the skin.

3. Remove the plug at the bottom of the housing and drain the lubricant while the unit is warm. Allow enough time for all the old lubricant to drain completely.
4. Clean the drain plug. For magnetic drain plugs, a piece of key stock or any other convenient steel slug may be used to short the two magnetic poles and divert the magnetic field.
5. After cleaning the drain plug, install and tighten the plug 30 lbf·ft (41 N·m).

Axle Filling

1. With the vehicle on a level surface, fill the axle housings to the bottom of the oil fill hole (in the carrier or housing) with recommended lubricant; see **Table 1**. Refer to **Table 2** for Detroit drive axle lubricant capacities.
2. Install the fill hole plug and tighten it 30 lbf·ft (41 N·m).
3. After filling the carrier and housing assembly with lubricant, drive the vehicle unloaded for one or two miles (two or three kilometers) at speeds not to exceed 25 mph (40 km/h) to thoroughly circulate the lubricant throughout the assembly.

Detroit Drive Axle Lubricant Capacities	
Axle Model*	**Capacity: pints (liters)†**
ARS–13.0–2	15 (7)
ARS–15.0–2	15 (7)
ARS–17.5–2	15 (7)
ARS–19.0–2	15 (7)
ARS–20.0–2	15 (7)
ARS–21.0–2	15 (7)
ARS–21.0–4	23 (11)
ARS–23.0–4	23 (11)

* Model code may have a "D" in the prefix (for example, DA–RS–13.0–2).

† Quantities listed are approximate and include 1 pint (0.5 liter) for each wheel end and with the drive pinion at 3 degrees.

Table 2, Detroit Drive Axle Lubricant Capacities

Meritor Axles

Axle Draining and Flushing

1. Remove the plug at the bottom of the housing and drain the lubricant while the unit is warm. See **Fig 2** for an example of the rear axle differential on an MB Shuttle Bus, and **Fig 3** for an example of the axle housing on an XB Shuttle Bus. Allow enough time for all of the old lubricant to drain completely.
2. Flush the unit with clean flushing oil, then drain it completely.

IMPORTANT: Do not flush axles with solvent, such as kerosene.

3. Clean the drain plugs. For magnetic drain plugs, a piece of key stock or any other convenient steel slug may be used to short the two magnetic poles and divert the magnetic field.

NOTE: Meritor recommends using magnetic plugs with elements having a minimum pickup capacity of 2 pounds (1 kg) of low-carbon steel, in plate or bar form. Magnets will rapidly lose effectiveness as collected material bridges the gap between the two poles. Clean or change the plugs before this occurs. It may be necessary to clean or change the plugs one or more times between lubrication change intervals.

4. After cleaning the drain plugs, install and tighten them 35 lbf·ft (47 N·m).

Axle Filling

1. With the vehicle on a level surface, fill the axle housing to the bottom of the oil fill hole (in the carrier or housing) with an SAE 80W–90 multi-purpose gear lubricant, or an SAE 75W–90 multi-purpose synthetic gear lubricant. See **Fig 4**.

NOTE: Meritor axles have a small tapped and plugged hole located near and below the housing oil fill hole. This smaller hole is for the lubricant temperature sensor only, and must not be used as a fill or level hole.

2. Install the fill hole plug, and tighten it 35 lbf·ft (47 N·m).
3. After filling the carrier and housing assembly with lubricant, drive the vehicle, unloaded, for 1 or 2 miles (2 or 3 kilometers) at speeds not to exceed 25 mph (40 km/h), to thoroughly circulate the lubricant throughout the assembly. See **Table 3** for lubricant capacity.

Meritor Drive Axle Lubricant Capacities	
Axle Model	**Capacity: pints (liters)***
RS–13–120	16 (7.6)
RS–15–120	16 (7.6)
RS–17–145	33.6 (15.9)
RS–19–145	34.4 (16.3)
RS–21–145	32 (15.1)
RS–23–160	42 (19.9)
RS–26–180	46.6 (22)

* Quantities listed are approximate and include 1 pint (0.5 liter) for each wheel end and with the drive pinion at 3 degrees.

Table 3, Meritor Drive Axle Lubricant Capacities

35–03 Axle Breather Checking

The axle housing breather must remain unobstructed. Whenever the axle lubricant level is checked, also check that the axle breather is open. Check more often under poor operating conditions. If the breather is plugged, clean or replace it as needed.

For component locations on a Detroit axle, see **Fig. 1**. Meritor axles are shown in **Fig. 2** and **Fig. 3**.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Wheel Nut Checking	40–01

40–01 Wheel Nut Checking

IMPORTANT: In addition to the maintenance interval in this manual, check the wheel nut torque the first 50 to 100 miles (80 to 160 km) of operation after a wheel has been removed and installed. The vehicle should be taken to a Freightliner dealer to ensure that the wheel nuts are tightened correctly.

⚠ CAUTION

Too little wheel nut torque can cause wheel shimmy, resulting in wheel damage, stud breakage, and extreme tire tread wear. Too much wheel nut torque can break studs, damage threads, and crack discs in the stud hole area.

For hub-piloted, 8- and 10-stud wheels, torque values vary with the stud size. See **Fig. 1** for the tightening sequence of hub-piloted, 8- and 10-stud wheels. Before tightening, apply 2 drops of SAE 30W oil to a point between the nuts and flanges.

Tighten the wheel nuts.

IMPORTANT: The vehicle should be taken to a Freightliner dealer to ensure that the wheel nuts are tightened correctly.

- On 8-stud or 10-stud, hub-pilot hubs with 20-mm studs, tighten the wheel nuts 280 to 310 lbf·ft (380 to 420 N·m). For the correct tightening sequence, see **Fig. 1**.
- On 8-stud or 10-stud, hub-pilot hubs with 22-mm studs, tighten the wheel nuts 450 to 500 lbf·ft (610 to 678 N·m). For the correct tightening sequence, see **Fig. 1**.

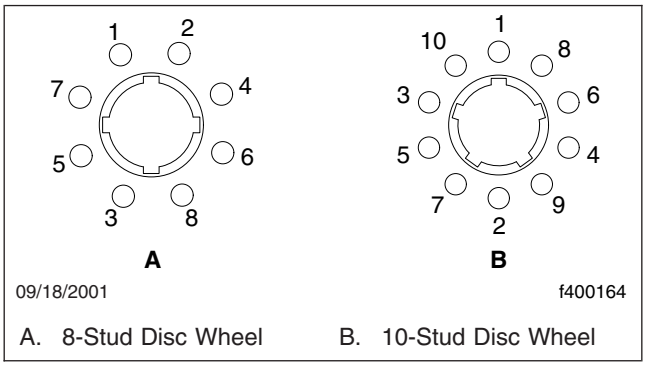


Fig. 1, Wheel Nut Tightening Sequence (8- and 10-stud hub-piloted wheels)

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Driveline Inspection and Lubrication	41–01

41–01 Driveline Inspection and Lubrication

Inspection

Before lubricating the driveline U-joints and slip-joints, make the following checks.

1. Check that the yoke-strap capscrews are tightened 50 to 60 lbf·ft (68 to 81 N·m).

NOTICE

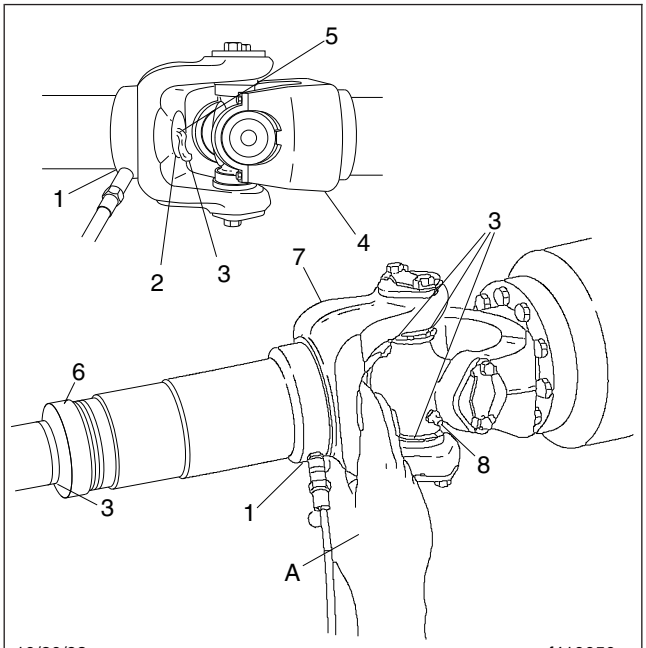
Do not overtighten the yoke-strap capscrews, due to the extreme load occurring at high-speed rotation. A loose or broken capscrew at any point in the driveline weakens the driveline connection, which could eventually result in serious vehicle damage.

2. Check the slip-joints for spline wear by trying to bend the sleeve-yoke and splined shaft back and forth. If looseness is greater than 0.007 inch (0.18 mm), replace both the sleeve-yoke and the splined shaft.
3. Check the driveshaft for missing balance weights, and for debris buildup. Remove any buildup. If any balance weights are missing, remove the driveshaft and have it balanced. For instructions, see **Group 41** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
4. Check that the yoke plug is not loose or missing. Replace the yoke plug if needed. If the yoke plug is missing, the splined shaft may be hitting the yoke plug and knocking it out; check the driveshaft for proper length.

U-Joint Lubrication

1. Wipe all old grease and dirt from each U-joint grease fitting.
2. Use a hand-type grease gun, or a high-pressure gun with a low-pressure adaptor, to lubricate the U-joints. See **Fig. 1**.

NOTE: If a low-pressure adaptor is not used with the high-pressure gun, the U-joints may not receive enough lubricant.



A. After grease appears, cover the pressure-relief hole while continuing to lubricate.

1. Slip-Joint Grease Fitting (with grease gun attached)
2. Yoke Plug
3. Grease
4. Half-Round Yoke
5. Yoke Plug Pressure-Relief-Hole
6. Slip-Joint Seal
7. Full-Round Yoke
8. U-Joint Grease Fitting

Fig. 1, Slip-Joint and U-Joint Lubricating

3. Using lithium 12-hydroxy stearate grease (NLGI grade 1 or 2, with EP additives), lubricate until new grease can be seen at all four U-joint seals.

NOTICE

Fresh lubricant must be seen escaping from *all four* of the bearing cup seals of each U-joint. If not, the U-joint may fail prematurely.

4. If the bearing will not take grease, replace the U-joint assembly. For instructions, see **Group 41** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
5. Check the old grease. If it appears rusty, gritty, or burned, replace the U-joint assembly. For instructions, see **Group 41** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

6. Wipe any excess grease from the seals and grease fittings.

Slip-Joint Spline Lubrication

1. Wipe all old grease and dirt from the slip-joint grease fitting.
2. Use a hand-type grease gun or a high-pressure gun with a low-pressure adaptor, to lubricate the slip-joint. Using lithium 12-hydroxy stearate grease (NLGI grade 1 or 2, with EP additives), lubricate until fresh grease appears at the pressure-relief hole in the yoke plug. Then cover the relief hole with your finger, as shown in **Fig. 1**, while continuing to lubricate until fresh grease appears at the slip-joint seal. This ensures complete lubrication of the splines.
3. Wipe any excess grease from the pressure-relief hole, slip-joint seal, and grease fitting.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
ABS Tone Rings Cleaning	42–14
Air Dryer Checking	42–01
Air Dryer Desiccant and Coalescent Filter Replacing	42–02
Air Dryer Desiccant and Coalescent Filter Replacing, Midland	42–17
Air Dryer Inspecting	42–03
Air Dryer Inspecting, Midland	42–16
Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV–2	42–04
Air-Actuated Parking Brake Cable Checking and Adjusting	42–18
Bendix Hydro-Max® Brake System Inspecting	42–06
Brake Caliper Slide Pin Lubricating, Bosch Brakes	42–13
Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes	42–12
Brake Inspection	42–19
Brake Lines Checking, Hydraulic Disc Brakes	42–07
Brake Lining Wear Checking, Hydraulic Disc Brakes	42–08
Camshaft Bracket Bushing Lubricating	42–09
Drum Brake Shoe Roller Lubricating	42–15
Foot Brake Valve Actuator Lubricating, Bendix E–6	42–10
Relay Valve Checking, Midland	42–11
Slack Adjuster Lubricating	42–05

42–01 Air Dryer Checking

During cold-weather operation, check the operation of the end cover heater and thermostat assembly.

1. With the ignition switch in the ON position, check for voltage to the heater and thermostat assembly. Unplug the electrical connector at the air dryer, and place the test leads of a voltmeter on each of the pins of the male connector. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check that a good ground path exists.
2. Check the thermostat and heater operation. Turn the ignition switch to the OFF position and cool the end cover assembly to below 40°F (4°C). Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 1.5 to 3.0 ohms for the 12-volt heater assembly.

   Warm the end cover assembly to over 90°F (32°C) and again check the resistance. It should exceed 1000 ohms. If it does, the thermostat and heater assembly is operating properly. If it does not, replace the purge-valve housing assembly, which includes the heater and thermostat assembly.

42–02 Air Dryer Desiccant and Coalescent Filter Replacing

NOTE: Desiccant change intervals may vary from vehicle to vehicle. Typical desiccant cartridge life is three years. However, if experience has shown that extended or shortened life has resulted on a particular installation, then the interval can be increased or decreased accordingly.

Bendix AD-9

1. Park the vehicle on a level surface. Apply the parking brakes and chock the tires.
2. Completely drain all air reservoirs. Air pressure gauges should read 0 psi (0 kPa).
3. Loosen the desiccant cartridge with a strap wrench at the base of the cartridge. Spin off the cartridge and discard it.
4. Remove the O-ring from the threaded neck and discard it.
5. Remove the coalescent filter and discard it.

IMPORTANT: Lubricate the new O-rings prior to installation.

6. Install the new small O-ring in the groove on the bottom of the new coalescent filter.
7. Insert the coalescent filter with the O-ring end going into the air dryer opening first. The end of the filter with the "X" will then be facing out.
8. Install the other new O-ring over the threaded neck of the desiccant cartridge.
9. Screw on the desiccant cartridge until resistance is detected. Then, tighten the cartridge 1/4 to 3/4 of a turn by hand.
10. Before placing the vehicle in service, perform the test below.
    - 10.1 Start the engine and build air pressure to 120 psi (827 kPa).
    - 10.2 Listen for the purge valve to open and release air. A large volume of air will be expelled, followed by a slow flow of air lasting approximately 30 seconds.
    - 10.3 Shut down the engine.
    - 10.4 Perform the inspections in **Maintenance Operation 42–03**.

Bendix AD-IP

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Using a wrench or a socket, loosen the desiccant cartridge bolt. Then separate the desiccant cartridge from the end cover.
3. Pull the cartridge bolt out of the cover and remove the cartridge.

⚠ WARNING

Do not attempt to disassemble the desiccant cartridge assembly. Parts for the assembly are not available and the cartridge contains a 150 lb

spring that cannot be mechanically caged. Disassembly could release the spring, resulting in personal injury.

4. Remove and discard both O-rings from the cartridge bolt.
5. Using a clean rag, wipe clean the inside of the end cover. Clean the cartridge bolt bore in the end cover, and the sealing surfaces for the large- and small-diameter desiccant cartridge sealing rings.
6. Inspect the end cover for physical damage, then inspect all air line fittings for corrosion; replace as necessary.
7. Clean and inspect the bolt, paying attention to the threads and O-ring grooves.

IMPORTANT: Use only the grease supplied with Bendix replacement kits.

8. Lubricate the O-rings, bolt O-ring grooves, sealing rings, and cartridge grooves. Lubricate the end cover bore for the bolt.
9. Install both O-rings on the cartridge bolt, then, using a twisting motion, insert the assembled desiccant cartridge bolt in the end cover.
10. Install the desiccant cartridge on the end cover, making sure the cartridge is properly seated and flush on the end cover.

NOTE: It may be necessary to rotate the cartridge slightly until the anti-rotation lugs are properly aligned and allow the cartridge to rest flush against the end cover.

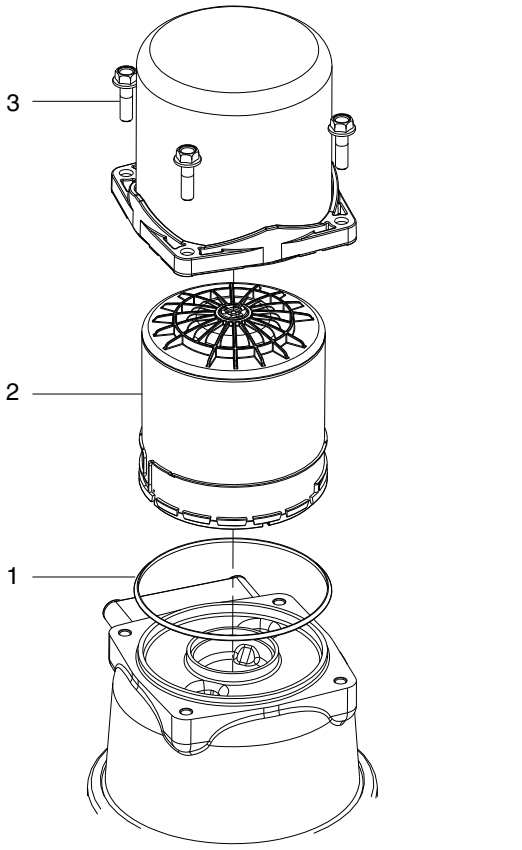
11. Using a wrench or socket, tighten the desiccant cartridge bolt 50 lbf·ft (68 N·m). **Do not** overtorque.
12. Before placing the vehicle in service, perform the test below.
    - 12.1 Close all reservoir drain cocks.
    - 12.2 Build system pressure to governor cut-out, and note that the AD-IP air dryer purges with an audible escape of air.
    - 12.3 Fan the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by a purge at the AD-IP air dryer exhaust.
    - 12.4 Check for excessive leakage around the head of the desiccant cartridge where it contacts the end cover. With the compressor in loaded mode (compressing air), apply a soapy solution to these areas, and observe that any leakage does not exceed a 1-inch bubble in 1 second. If leakage exceeds this measure, remove and re-install the desiccant cartridge.

Haldex PURest[1]

NOTE: The PURest cartridge contains both the desiccant and filter in one piece.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Remove the four mounting bolts and discard. See **Fig. 1**. Lift the canister about 1/2 inch and remove.
3. Place the assembly upside-down as shown in **Fig. 2**. Press the cartridge down to compress the rubber spring then rotate counterclockwise 45 degrees to release the cartridge. The cartridge itself contains no hazardous material, but there may be a small amount of oil from the compressor.
4. Clean the inside of the canister and aluminum housing.
5. Remove the cartridge O-ring and discard.
6. Remove the new cartridge from the kit and make certain the rubber spring is attached. See **Fig. 3**.
7. Install the new cartridge into the canister. Align the slots on the cartridge with the dimplets inside the canister. Press the cartridge into the canister and rotate clockwise 45 degrees to engage the cartridge, as shown in **Fig. 4**.
8. Place a new O-ring on the aluminum housing.
9. Place the cartridge assembly on the air dryer housing and install four new mounting bolts. Use an alternating diagonal pattern and tighten the bolts 35 to 40 lbf·ft (47 to 54 N·m).
10. Before placing the vehicle in service, perform the test below.

[1]Information in this section is provided by Haldex and is used with permission.



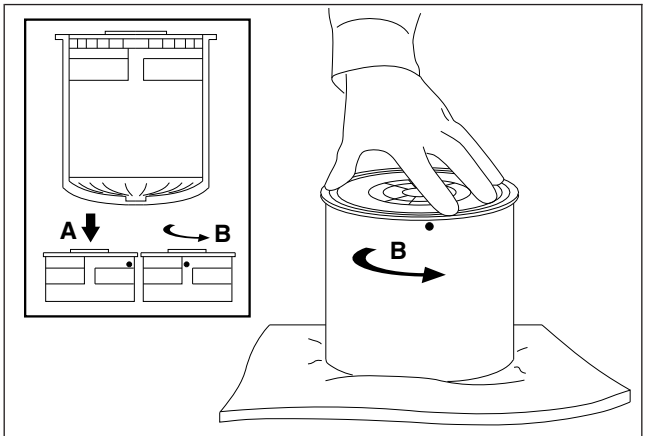
1. O-ring
2. Cartridge
3. Mounting Bolts

Fig. 1, PURest Air Dryer Assembly

10.1 Start the engine and build air pressure to 100 psi (690 kPa) and shut-off the engine.

10.2 Check for air leaks at the inlet, outlet, and canister assembly. Correct any leakage problem.

10.3 Restart the engine and build-up pressure to cut-out pressure. At cut-out pressure, the air dryer purge valve opens and immediately expels a large volume of air, followed by a slow flow of air lasting approximately 30 seconds.



A. Canister/cartridge assembly shown upside-down.
B. Rotate the cartridge counterclockwise 45 degrees to release it from the canister.

Fig. 2, Releasing the Cartridge

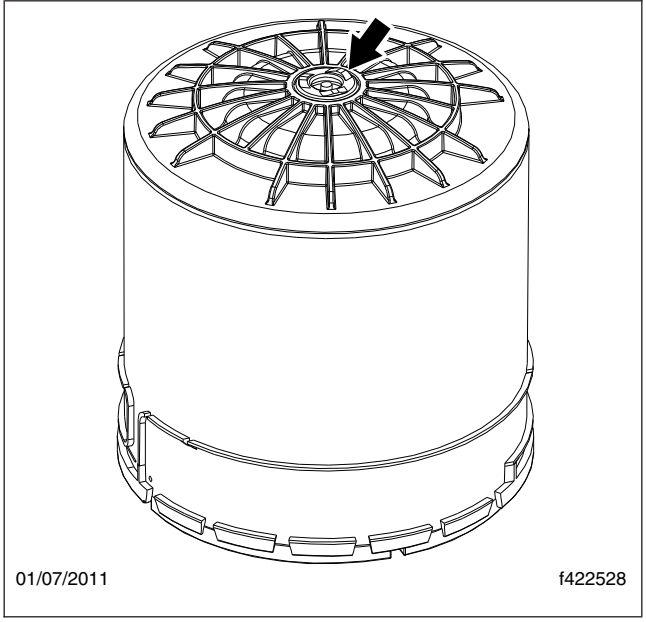
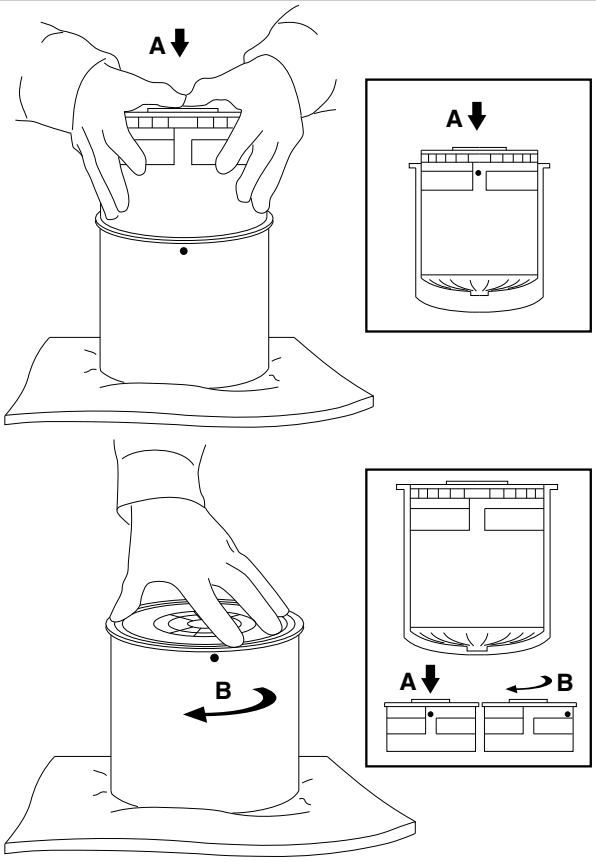


Fig. 3, New Cartridge with Rubber Spring

42–03 Air Dryer Inspecting

1. Check the reservoirs for moisture. A small amount (a teaspoon or less) is normal. Larger amounts may mean that the desiccant needs to be replaced. Check the mounting and connecting lines.



A. Install the new cartridge into the canister.
B. Press the cartridge into the canister and rotate clockwise 45 degrees to engage the cartridge.

Fig. 4, Cartridge Rotation and Engagement

2. Tighten the fasteners attaching the air dryer to the vehicle. Use the following torque values.

   28 lbf·ft (38 N·m) for SAE grade 5, 3/8–16 fasteners.

   135 lbf·ft (183 N·m) for SAE grade 5, 5/8–11 fasteners.

   Check all air lines, fittings, and electrical connections for damage, leakage, or looseness.

3. Replace damaged or leaking parts, and tighten loose fittings or electrical connections.

42–04 Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV–2

Disassemble the drain valve, clean the parts with mineral spirits, and inspect the parts. Replace all rubber parts and any worn or damaged parts; use only genuine Bendix replacement parts or kits. Assemble and install the valve, then check for proper operation and leakage. For instructions, see **Group 42** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

42–05 Slack Adjuster Lubricating

IMPORTANT: Perform **MOP 42–19** before lubricating the slack adjusters.

Automatic slack adjusters must be lubricated periodically to ensure proper brake operation.

⚠ WARNING

Manually adjusting an automatic slack adjuster to bring the pushrod stroke within legal limits is likely masking a mechanical problem. Adjustment is not repairing. Before adjusting an automatic slack adjuster, troubleshoot the foundation brake system and inspect it for worn or damaged components. Improperly maintaining the vehicle braking system may lead to brake failure, resulting in property damage, personal injury, or death.

Haldex

NOTICE

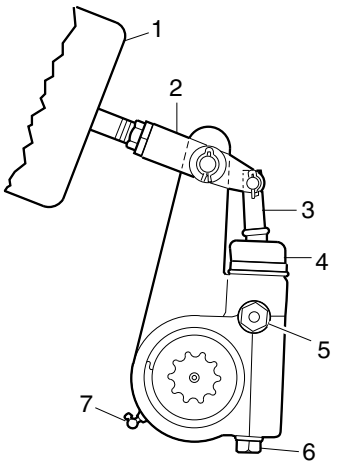
Do not use moly-disulfide-loaded grease or oil. Both the life and reliability of the slack adjuster will be reduced if this type of grease is used.

Lubricate a Haldex automatic slack adjuster at the grease fitting with any extreme-pressure NLGI Grade 1 or Grade 2 grease if the operating temperature is –20°F (–29°C) and above. If the operating tempera-

ture is below –20°F (–29°C), use a low-temperature extreme-pressure grease.

Meritor

Lubricate the slack adjuster at the grease fitting until grease is forced past the pressure-relief capscrew or past the gear splines around the inboard snap ring. Use high-temperature, NLGI Grade 1 waterproof grease. See **Fig. 5**.



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1. Brake Chamber
2. Clevis
3. Actuator Rod
4. Boot
5. Pull-Pawl Seal
6. Manual Adjusting Nut
7. Grease Fitting (or Lube Plug)

Fig. 5, Meritor Automatic Slack Adjuster (other slack adjustors are similar)

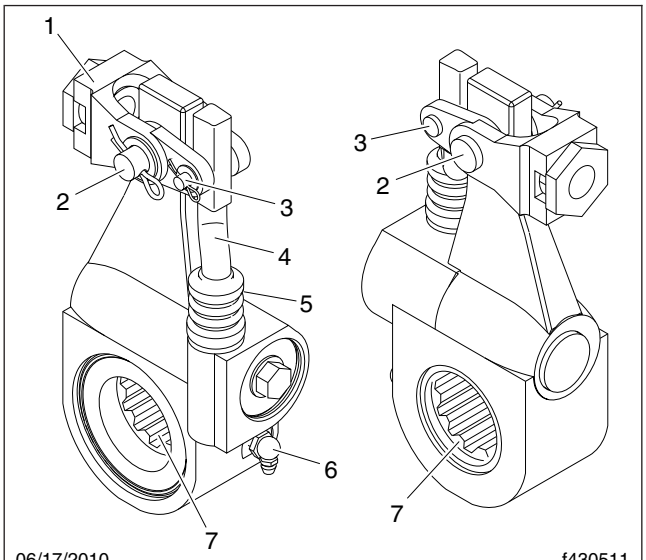
Bendix

Using a quality multipurpose chassis lubricant, NLGI Grade 2, lubricate the automatic slack adjuster through the lube fitting. See **Fig. 6**. Lubricate the slack adjuster until clean lubricant flows from the grease relief opening in the boot.

42–06 Bendix Hydro-Max® Brake System Inspecting

NOTE: If possible, remove both caps when filling the reservoir. If only one cap can be removed, allow ample time for the reservoir to fill.

1. Check the fluid level in the hydraulic brake fluid reservoir. If needed, fill the reservoir up to the ridge that surrounds the reservoir. See **Fig. 7**. Use only heavy-duty brake fluid, DOT 3.



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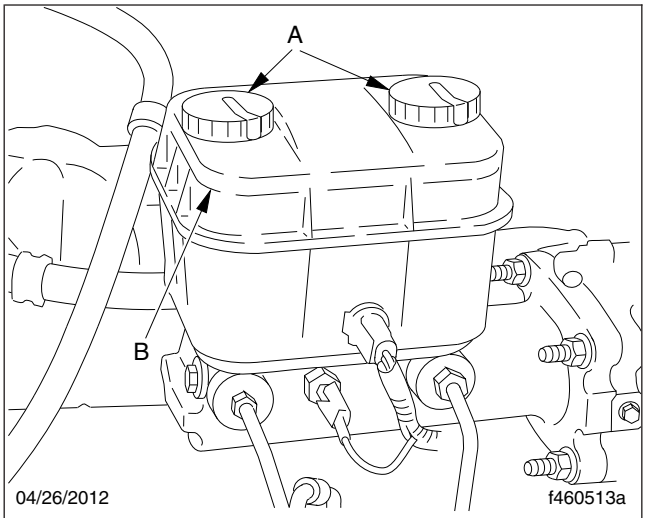
1. Yoke
2. Yoke Pin
3. Link Pin
4. Link
5. Boot
6. Lube Fitting
7. Worm Gear

Fig. 6, Bendix Automatic Slack Adjuster



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A. Open caps and check fluid level.
B. Fill to this level.

Fig. 7, Hydraulic Brake Fluid Reservoir

2. Check all hydraulic lines and fittings for damage, leakage, or looseness.

   Replace damaged or leaking components, and tighten loose fittings.

3. Check the brake module for leaks. If leaks are found, repair or replace the brake module. See **Group 42** of the *Shuttle Bus Chassis Workshop Manual* for replacement instructions, or take the vehicle to an authorized Freightliner dealer.
4. Check the electrical connections and harnesses. Make sure the connectors are fully seated and the harnesses are not chafed or cut. Repair or replace any damaged harness. Disconnect any loose connectors and inspect the terminals for corrosion. If corrosion is present, replace the terminals. If corrosion is not present, reconnect the connector.
5. Check the fuse for the hydraulic brake booster pump, as follows.
   - 5.1 Open the cover to the main power distribution module (PDM).
   - 5.2 Pull the fuse in position F6 for the Hydro-Max relay.
   - 5.3 Inspect the relay to make sure the fuse is not damaged. If the fuse is damaged, install a new fuse. If the fuse is not damaged, install the fuse in position F6.
   - 5.4 Close the PDM cover.
6. Check the operation of the Hydro-Max brake booster, as follows.
   - 6.1 With the ignition off, depress the brake pedal and listen for the back-up motor to engage. The operator should also feel the pedal force relieve and the pedal should depress easily.
   - 6.2 With the engine running and the parking brake released, ensure that the BRAKE warning indicator light is **not** on. This is a dual indicator, and indicates that the parking brake is set, and warns if there is a Hydro-Max failure condition other than loss of back-up motor power.

42–07 Brake Lines Checking, Hydraulic Disc Brakes

Check all hydraulic lines and fittings for damage, leakage, or looseness.

Replace damaged or leaking components, and tighten loose fittings.

42–08 Brake Lining Wear Checking, Hydraulic Disc Brakes

Before checking lining wear with the wheel removed, review the following brake lining exposure warnings.

⚠ WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

To minimize the possibility of creating airborne brake lining dust, clean the dust from the brake rotor, brake caliper, and brake assembly, using an industrial-type vacuum cleaner equipped with a high-efficiency filter system. Then, using a rag soaked in water and wrung until nearly dry, remove any remaining dust. Do not use compressed air or dry brushing to clean the brake assembly.

1. Check lining wear.
   - 1.1 Apply the parking brakes. Chock the tires to prevent vehicle movement.
   - 1.2 Remove one or more of the lining inspection plugs, and measure brake lining thickness.
   - 1.3 On front and rear axles, replace linings worn to less than 3/16 inch (4.8 mm).
   - 1.4 Make sure that the brake rotor and linings are free of oil and grease.
   - 1.5 Install the inspection plug(s).
2. If the wheel and hub assembly is removed from the axle, check lining wear. Replace the linings

on all brake assemblies if worn to less than 3/16 inch (4.8 mm) at the thinnest point.

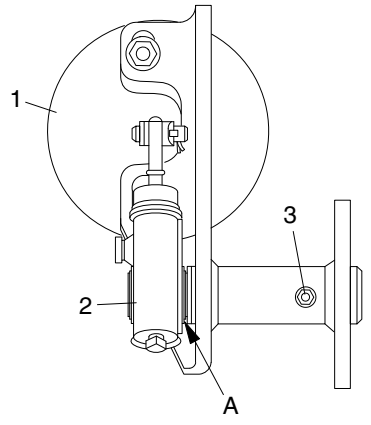
NOTE: To replace the brake linings, see the applicable brake section in **Group 42** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

42–09 Camshaft Bracket Bushing Lubricating

IMPORTANT: Perform **MOP 42–19** before lubricating the camshaft brackets.

Pump multipurpose chassis grease (NLGI Grade 1 or 2) into the chamber bracket until it appears at the slack adjuster end of the bracket. See **Fig. 8**. Use care that no grease enters the drum cavity. If grease leaks out under the camhead, the camshaft grease seal is worn or damaged, or is installed backwards.

NOTE: The use of meter-type fittings, having a maximum 40 psi (275 kPa) pressure relief at shutoff, is recommended.



A. Grease exit
1. Brake Chamber
2. Slack Adjuster
3. Grease Fitting

Fig. 8, Camshaft Bracket Bushing Lubrication

42–10 Foot Brake Valve Actuator Lubricating, Bendix E–6

1. Remove the brake valve. For instructions, see **Group 42** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
2. From the outside of the cab, pull the valve away from the frontwall and remove the brake plunger.
3. Wipe off the old grease from the plunger and the adaptor.
4. Inspect the bore of the adaptor and the sliding surface of the plunger. While some discoloration is permissible, there should be no pitting or roughness of the adaptor bore or the sliding surface of the plunger. If pitting or roughness exists, replace damaged parts with new ones.
5. Lubricate the adaptor bore and the sliding surface of the plunger with an approved silicone-based grease, Dow Corning 55 O-Ring Lubricant (formerly Molykote DC–55M), or Loctite® V–755 O-Ring Lubricant.
6. Using a new gasket, install the plunger and brake valve following the instructions in **Group 42** of the *Shuttle Bus Chassis Workshop Manual*.

42–11 Relay Valve Checking, Midland

Chock the tires. Start the engine and run it long enough to pressurize the air system to at least 80 psi (550 kPa), then shut down the engine.

Repeat as necessary, to maintain 80 psi (550 kPa) pressure during this check.

Clean off road grime from the relay valve, and any debris from the valve exhaust port. Listen for air leakage around the fittings or exhaust port. Tighten the fittings as necessary. Use two wrenches to avoid twisting the tubing.

If the valve fails this check, or is damaged, repair or replace it; see the *Midland Service Manual* for instructions. Remove the chocks from the tires.

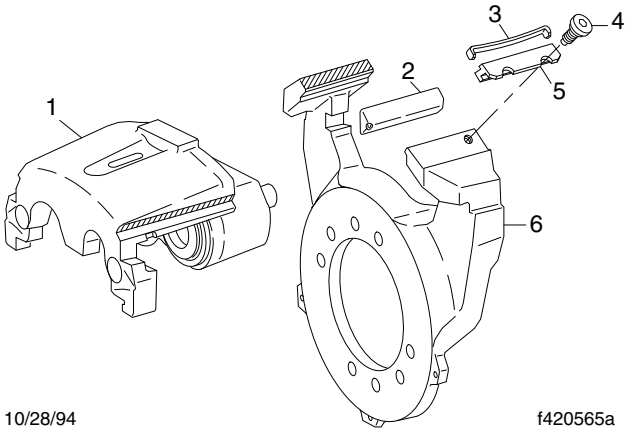
42–12 Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes

⚠ WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

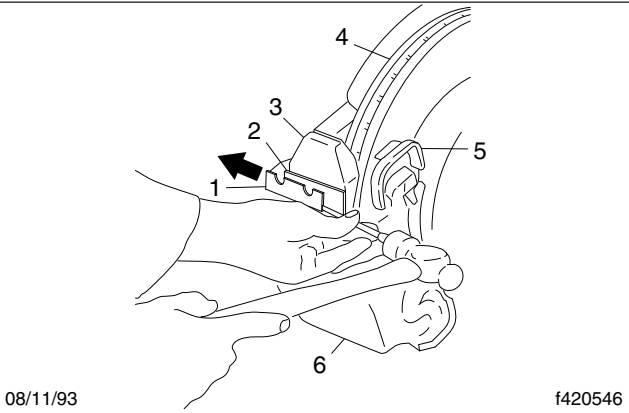
IMPORTANT: Lubricate every 6 months or every 18,000 miles (28 800 km), whichever comes first.

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the front or the rear tires, depending on which axle you are working on.
2. Raise the vehicle off of the ground and securely support it with jack stands.
3. Remove the wheel from each wheel end. For instructions, see **Group 40** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
4. Place a stool near the axle to rest the caliper on after it is removed.
5. Remove the key-retaining fastener from the anchor plate. See **Fig. 9**.
6. Using a hammer and drift, carefully drive out the key and spring. See **Fig. 10**. Be careful not to nick the anchor plate rail.
7. Insert a large flat-bladed screwdriver through the caliper vent window and into the rotor fins. Pry the caliper outward; this will push the pistons back slightly into the caliper, making removal easier.
8. Grasp the caliper, swing it out and lift it from the anchor plate. Rest the caliper on the stool. For ease of removal, swing the caliper on the forward anchor plate torque rail (the large one opposite the key and spring rail).



1. Caliper
2. Wear Shim
3. Spring
4. Fastener
5. Key
6. Anchor Plate

Fig. 9, Anchor Plate and Key Fastener



1. Key
2. Spring
3. Anchor Plate Upper Rail
4. Rotor
5. Outboard Brake Pad
6. Caliper Housing

Fig. 10, Driving Out the Key and Spring

9. Carefully remove the brake pads to avoid damaging them or getting grease on the pad faces. Set them aside.
10. Using brake cleaner or alcohol, remove old grease and road accumulation from the caliper V-ways, the anchor plate rails, and the shoe slots. Also clean the key and spring. See **Fig. 10** and **Fig. 11**.

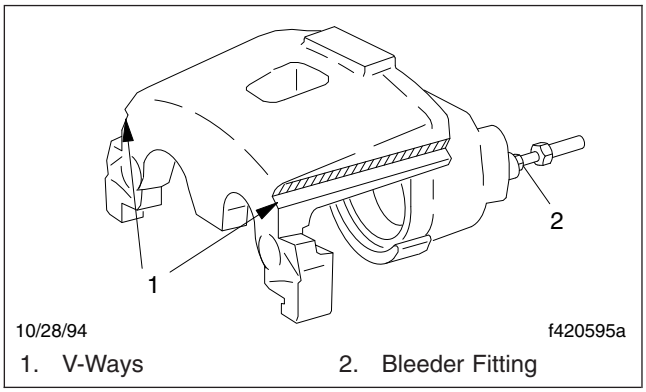


Fig. 11, Caliper V-Ways

11. Using a wire brush or wire wheel, remove any remaining debris from the V-ways, rails, shoe slots, key, and spring.
12. Inspect the caliper and ensure that the piston boots are in good condition with no punctures or tears, and that they are properly seated in the caliper. Check to see that the heat shields are properly seated. Repair or replace them if necessary.
13. Inspect the brake hoses for twists, cracks, blisters, or abrasions, and replace them if necessary.
14. Apply two level teaspoons of Aeroshell Grade 5 (ES–1246) grease on each side of the assembly. Apply it evenly along the full length of the V-way groove and anchor plate rail, and apply one level teaspoon evenly on both sides of the key and spring. After the caliper is installed, pack any accumulation of grease at each end of the rail and along the top of the rail or key at the V-way.
15. Being careful not to get grease or dirt on the pad face, reinstall each brake pad.
16. Grasp the caliper firmly, rest the V-ways on the forward anchor plate torque rail (the large rail), and swing the caliper into place. Make sure that the brake hose is not twisted. Do not get grease on the pad faces or rotor surfaces.
17. With the caliper installed and firmly seated on the forward rail (large rail), position the key and spring between the caliper V-way and the anchor rail from the in-board end of the anchor rail.
18. Carefully drive the key and spring into place. Install the key-retaining fastener and torque it 12 to 18 lbf·ft (16 to 24 N·m).
19. Install the wheels. For instructions, see **Group 40** of the *Shuttle Bus Chassis Workshop Manual*.
20. Before moving the vehicle, press the brake pedal several times to bring the pistons back to the normal position.
21. Raise the vehicle, remove the jack stands, and lower the vehicle to the ground.
22. Remove the chocks from the tires.
23. Test drive the vehicle and ensure that the brakes operate properly.

42–13 Brake Caliper Slide Pin Lubricating, Bosch Brakes

⚠ WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

NOTE: See the *Bosch Pin Slide Disc Brakes Service Manual* for more information, or take the vehicle to an authorized Freightliner dealer.

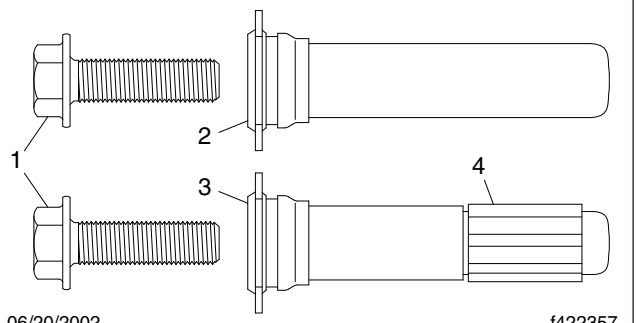
Apply 1/8 oz (3.5 g) Aeroshell grade 5 grease to each of the two guide pin and guide pin bore sets. See the *Bosch Pin Slide Disc Brakes Service Manual* for additional information.

⚠ DANGER

The correct pins, bolts, and bolt torque must be used. If not, brake function could be impaired and lead to loss of control of the vehicle, which could result in personal injury, death, or property damage.

IMPORTANT: The ZOH-T caliper assembly is similar in appearance to the existing ZOPS caliper. The only obvious difference is that one of the anchor plate slide pins (trailing side) has notches for identification. With ZOH-T calipers, install the solid pin (no bushing) only in the an-

chor plate leading hole position. Install the pin with the rubber bushing and notches only in the anchor plate trailing hole position. See **Fig. 12**. Tighten the leading-side pin first, then tighten the trailing-side pin.



1. Flanged Bolt
2. Leading Pin
3. Trailing Pin
4. Rubber Bushing

Fig. 12, ZOH-T Slide Pins and Bolts

Tighten ZOH-T bolts 93 to 107 lbf·ft (126 to 145 N·m). Tighten ZOPS bolts 70 to 80 lbf·ft (95 to 108 N·m).

42–14 ABS Tone Rings Cleaning

⚠ CAUTION

An accumulation of road salt, dirt, and debris on the antilock braking system (ABS) tone rings and sensors can cause the ABS warning light to illuminate.

IMPORTANT: During winter months in areas where corrosive materials are used on the highways, periodically clean the underside of the vehicle to ensure proper ABS functioning. Thoroughly clean the wheel/ABS sensor/tone ring areas, removing all corrosive materials.

42–15 Drum Brake Shoe Roller Lubricating

⚠ WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the tires.
2. Raise the front or the rear axle and then place safety stands under the frame or axle. Be sure that the stands will support the weight of the vehicle.
3. Remove the wheels and the brake drums.

⚠ CAUTION

Before you back off automatic slack adjusters, see the slack adjuster manufacturer's service information for instructions. Failure to do so could result in damage to the slack adjusters.

4. Back off the slack adjusters.
5. Push down on the bottom brake shoe and then (by pulling on the roller-retaining clip) remove the bottom cam roller.
6. Lift the top brake shoe and then (by pulling on the roller-retaining clip) remove the top cam roller.
7. Clean the rollers, retaining clips, and the roller pin recesses in the brake shoes thoroughly.

⚠ CAUTION

Do not apply grease to the outer diameters of the rollers (where they contact the cam head).

8. Apply a good-quality, multipurpose chassis grease to the retaining clips, brake spider, and the shoe rollers where they contact the brake shoes.

9. One at a time, pull each brake shoe away from the cam and install the top and the bottom shoe rollers.
10. Install the brake drums and the wheels.

⚠ DANGER

Do not operate the vehicle until the brakes have been adjusted and checked for proper operation. To do so could result in inadequate or no braking ability, which could cause personal injury, or death, or property damage.

IMPORTANT: See the slack adjuster manufacturer's service information and adjust the brakes at the slack adjusters.

11. Remove the safety stands, lower the vehicle, and remove the chocks from the tires.
12. In a safe area, drive the vehicle and check for proper brake operation.

42–16 Air Dryer Inspecting, Midland

1. Check the reservoirs for moisture. A small amount (a teaspoon or less) is normal. Larger amounts may mean that the desiccant needs to be replaced. Check the mounting and connecting lines.
2. Tighten the fasteners attaching the air dryer to the vehicle. Use the following torque values.

   28 lbf·ft (38 N·m) for SAE grade 5, 3/8–16 fasteners.

   135 lbf·ft (183 N·m) for SAE grade 5, 5/8–11 fasteners.

   Check all air lines, fittings, and electrical connections for damage, leakage, or looseness.
3. Replace damaged or leaking parts, and tighten loose fittings or electrical connections.

42–17 Air Dryer Desiccant and Coalescent Filter Replacing, Midland

NOTE: Desiccant change intervals may vary from vehicle to vehicle. Typical desiccant cartridge life is three years. However, if experience has shown that extended or shortened life has resulted on a particular installation, then the interval can be increased or decreased accordingly.

For air dryer desiccant and filter replacement, order either kit DQ6022 or kit DQ6026. The DQ6022 kit contains 1 desiccant cartridge, 1 coalescent filter, and 2 O-rings. The DQ6026 kit contains 1 desiccant cartridge, 1 coalescent filter, and a heater cover. Follow the replacement procedure below.

Replacement

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the tires.
2. Completely drain all air reservoirs. Air pressure gauges should read 0 psi (0 kPa).
3. Loosen the desiccant cartridge with a strap wrench at the base of the cartridge. Spin off the cartridge and discard it.
4. Remove the O-ring from the threaded neck and discard it.
5. Remove the coalescent filter and discard it.

IMPORTANT: Lubricate the new O-rings prior to installation.

6. Install the new small O-ring in the groove on the bottom of the new coalescent filter.
7. Insert the coalescent filter with the O-ring end going into the air dryer opening first. The end of the filter with the "X" will then be facing out.
8. Install the other new O-ring over the threaded neck of the desiccant cartridge.
9. Screw on the desiccant cartridge until resistance is detected. Then, tighten the cartridge 1/4 to 3/4 of a turn by hand.

Operational Check

1. Start the engine and build air pressure to 120 psi (827 kPa).
2. Listen for the purge valve to open and release air. A large volume of air will be expelled, followed by a slow flow of air lasting approximately 30 seconds.
3. Shut down the engine and remove the chocks from the tires.
4. Perform the inspections in **Maintenance Operation 42–16**.

42–18 Air-Actuated Parking Brake Cable Checking and Adjusting

Check the air-actuated parking brake cable to ensure that the actuation system is in good working order, and for any adjustment that is needed.

1. Park the vehicle on a level surface and chock the tires.
2. Make sure the air system is fully charged, then shut down the engine.
3. Release the parking brake if it is applied.
4. Remove the cotter pin and clevis pin from the clevis at the brake lever. See **Fig. 13**.
5. Pull the brake lever until shoe-to-drum contact is made.

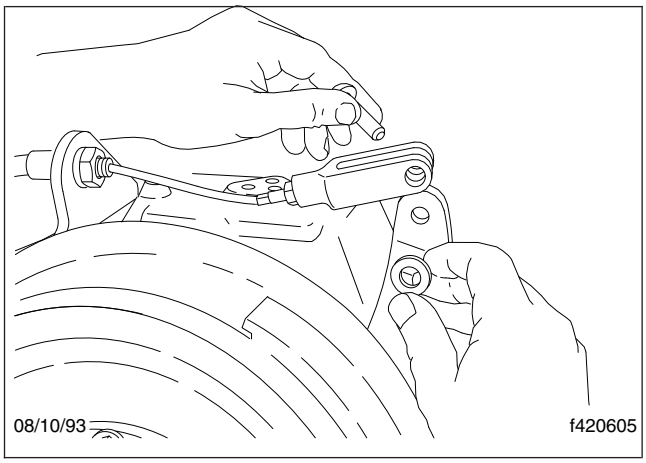
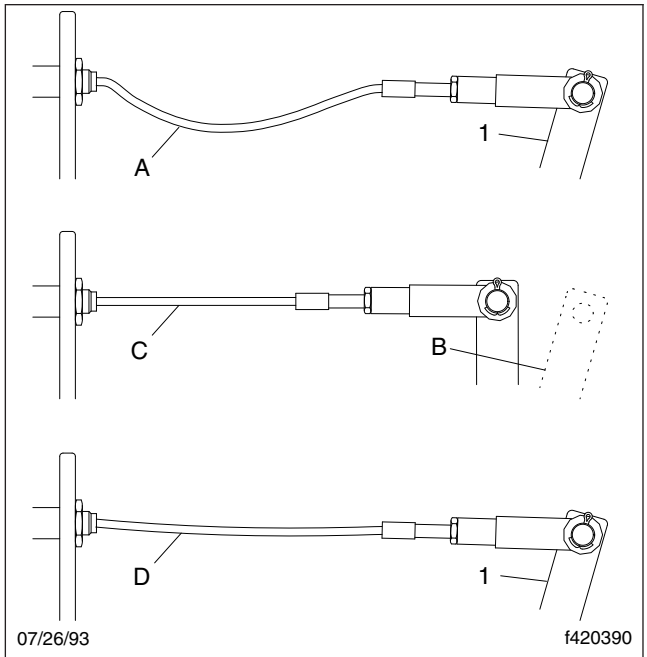


Fig. 13, Remove the Cotter Pin and Clevis Pin

6. If adjustment is required, loosen the jam nut on the cable and adjust the clevis so that the pin hole in the clevis aligns with the hole in the lever.
7. Install the clevis pin and a new cotter pin.
8. Tighten the clevis jam nut to 80 lbf·in (900 N·cm). When properly adjusted, the cable should have a very slight looseness to it. See **Fig. 14**.



A. Too Loose
B. Correct Position of Actuating Lever
C. Too Tight
D. Correct Cable Adjustment
1. Actuating Lever

Fig. 14, Parking Brake Cable Installation (typical)

9. Set the parking brake and remove the chocks.
10. Test the parking brake before returning the vehicle to service.

42–19 Brake Inspection

IMPORTANT: This procedure should be performed prior to lubrication of the brake components.

If the brakes must be repaired, or they require adjustment, see **Group 42** of the *Shuttle Bus*

Chassis Workshop Manual for repair, adjustment, and troubleshooting procedures. Or take the vehicle to an authorized Freightliner dealer.

Parking Brake Operational Check

⚠ CAUTION

Perform the following check in a clear safe area. If the parking brakes fail to hold the vehicle, personal injury or property damage may result.

1. With the engine running, and air pressure at cut-out pressure, set the parking brake.
2. Put the vehicle in the lowest gear and gently attempt to move it forward. The vehicle should not move. If the vehicle moves, the parking brakes are not operating correctly and must be repaired before the vehicle is returned to service.

Brake Component Inspection

1. Park the vehicle on a level surface, set the parking brake, and chock the tires. Once the tires are chocked, release the parking brake.

⚠ WARNING

Manually adjusting an automatic slack adjuster to bring the pushrod stroke within legal limits is likely masking a mechanical problem. Adjustment is not repairing. Before adjusting an automatic slack adjuster, troubleshoot the foundation brake system and inspect it for worn or damaged components. Improperly maintaining the vehicle braking system may lead to brake failure, resulting in property damage, personal injury, or death.

2. With the engine off, and 100 psi (689 kPa) of air tank pressure, have an assistant apply and hold an 80 to 90 psi (550 to 620 kPa) brake application.
3. Check to see if the colored over-stroke band on each brake chamber pushrod is exposed.

   If a band shows, the stroke is too long. Check the foundation brake components for wear or damage, and repair as needed.
4. Measure the applied chamber stroke. See **Table 1** for the proper stroke for the type of chamber being used. If the stroke is too short, the brakes may drag or will not fully apply. Check for improper operation or adjustment of the automatic slack adjuster.
5. Start the engine and build air pressure to at least 100 psi (689 kPa). Shut down the engine.
6. Check all of the foundation brake components for damage, wear, and loose or missing parts. Repair as needed.

Brake Chamber Stroke Specifications			
Chamber			Max Applied Stroke: inch (mm)
Manufacturer	Type*	Size†	
Meritor	Standard Stroke	9	Less than 1-1/2 (38)
		12	
		16	Less than 1-3/4 (44)
		20	
		24	Less than 1-7/8 (48)
	Long Stroke	24	Less than 2 (51)
	Standard Stroke	30	

* Long stroke design is indicated by a tag, or embossing, on the brake chamber.

† Specifications are relative to a brake application with 80 to 90 psi (550 to 620 kPa) air pressure in the brake chambers.

Table 1, Brake Chamber Stroke Specifications

Index, Alphabetical

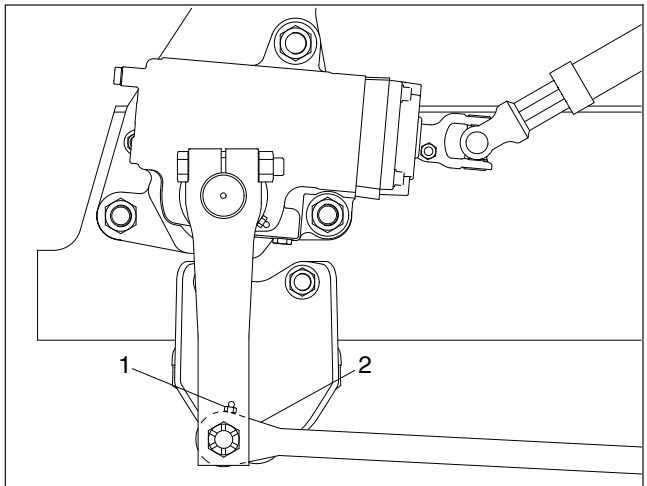
Title of Maintenance Operation (MOP)	MOP Number
Drag Link Lubricating	46–02
Power Steering Reservoir Fluid Level Checking	46–03
Power Steering Reservoir Fluid and Filter Changing	46–04
Steering Driveline Lubricating	46–01
Steering Gear Lubricating	46–05

46–01 Steering Driveline Lubricating

Wipe the grease fittings clean. Using a pressure gun, apply a lithium-based grease (NLGI grade 2) to the universal joints and slip-joint splines.

46–02 Drag Link Lubricating

1. Using a clean rag, wipe the dirt from both grease fittings on the drag link. See **Fig. 1**.



1. Grease Fitting
2. Drag Link (pitman arm end shown)

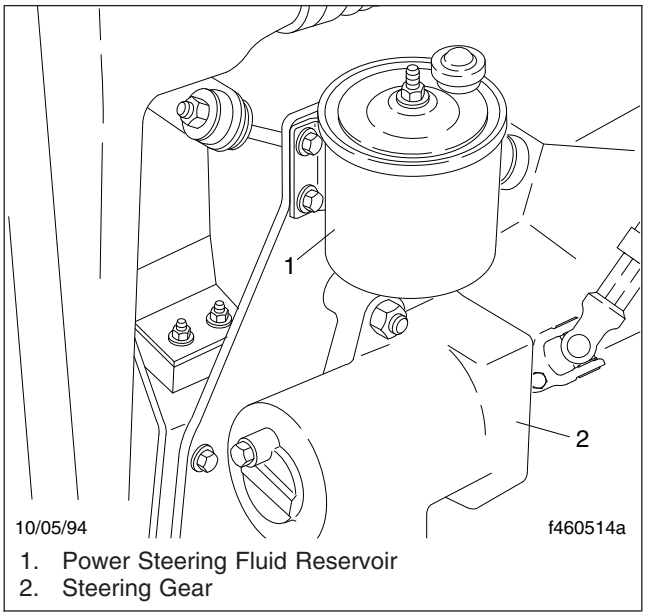
Fig. 1, Steering Drag Link Lubricating

2. Using a pressure gun, apply multipurpose chassis grease at the grease fittings until old grease is forced out of the socket.

NOTE: Use multipurpose chassis grease NLGI grade 1 (6% 12-hydroxy lithium stearate grease) or NLGI grade 2 (8% 12-hydroxy lithium stearate grease). The grade 2 chassis grease is preferred.

46–03 Power Steering Reservoir Fluid Level Checking

1. Clean around the power steering reservoir dipstick (fill cap) with a clean rag, then remove the dipstick. See **Fig. 2**.



1. Power Steering Fluid Reservoir
2. Steering Gear

Fig. 2, Power Steering Reservoir

⚠ WARNING

Fill only with approved clean fluid. Do not mix fluid types. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Fluid leakage could cause loss of power steering assist, possibly resulting in personal injury and property damage.

2. With the power steering fluid at operating temperature, check the fluid level on the dipstick. If below the "add" mark, add enough fluid to bring the level up to the full mark on the dipstick. See **Table 1** for approved power steering fluid.
3. Install the dipstick (fill cap) in the power steering reservoir.

Approved Power Steering Fluid	
Fluid Type	**Approved Fluid**
Automatic Transmission Fluid	Dexron III or equivalent*

* Use the same lubricant when assembling parts as is used in the power steering system. See the Warning above.

Table 1, Approved Power Steering Fluid

46–04 Power Steering Reservoir Fluid and Filter Changing

1. Remove the dipstick, 3/8–16 hexnut, and cover. See **Fig. 2**.
2. Drain the power steering reservoir by disconnecting the power steering hydroboost hose from the reservoir. Keep the hose in an upright position to prevent drainage of fluid.
3. Catch the fluid from the reservoir in a drain bucket, then cap the reservoir port.
4. Lift out the spring and filter element.
5. Thoroughly clean the reservoir with a lint-free cloth.
6. Install a new filter element, and position the spring on top of the filter element.
7. Fill the reservoir with approved power steering fluid, see **Table 1**.

⚠ WARNING

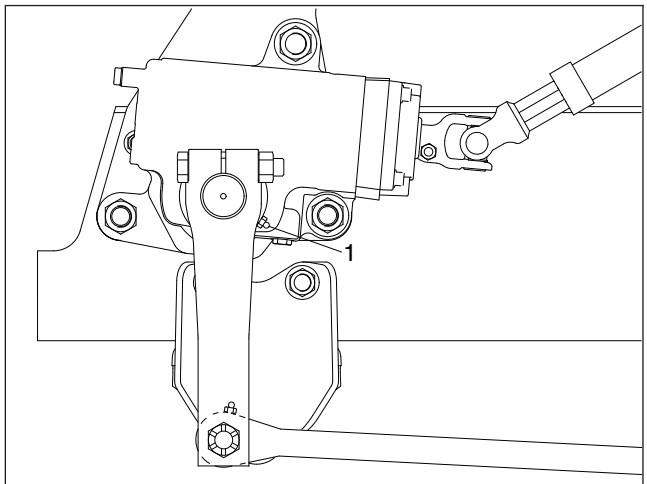
Fill only with approved clean fluid. Do not mix fluid types. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Fluid leakage could cause loss of power steering assist, possibly resulting in personal injury and property damage.

8. Place the disconnected end of the steering hydroboost hose in a drain bucket. *Do not start the engine while draining the system.*
9. Raise the front of the vehicle with a floor jack and support it with jack stands.
10. Have someone turn the steering wheel to full lock left and right, and capture the fluid flowing from the hose in the drain bucket. Add fluid to the reservoir, as needed.
11. Continue turning the steering wheel until clean power steering fluid flows from the hose into the drain bucket.
12. Remove the plug from the reservoir and reconnect the steering gear-to-reservoir hose to the reservoir.
13. Tighten the hose fitting nut finger-tight, then with a wrench, tighten until there is firm resistance. Tighten one-sixth turn more. Do not overtighten.

    Remove the jack stands and lower the vehicle.
14. Fill the reservoir with approved fluid, as needed. Start the engine and let it idle. Have someone turn the steering wheel from lock to lock until no bubbles are seen in the reservoir. Turn off the engine.
15. Install a new cover gasket, the cover, and the 3/8–16 hexnut. Tighten the hexnut 28 lbf·ft (38 N·m). Install the dipstick.
16. Start the engine and check the power steering reservoir fluid level. If the fluid level is low, add more of the approved fluid to bring the level up to the full mark on the dipstick.

46–05 Steering Gear Lubricating

1. Wipe off debris from the grease fitting. See **Fig. 3**.
2. Using a hand-type grease gun, apply multipurpose chassis grease until the grease starts coming out of the sector shaft dirt and water seal.



1. Sector Shaft Grease Fitting

Fig. 3, Sector Shaft Lubricating, TAS Series

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
CNG Fuel Block Housing Draining	47–03
CNG Fuel Leak Testing	47–04
CNG Fuel Tank Visual Inspecting	47–05
CNG High-Pressure Fuel Filter Replacing	47–06
CNG Low-Pressure Fuel Filter Replacing	47–07
Diesel Fuel Tank Draining and Vent Checking	47–01
Fuel/Water Separator Element Replacing	47–02
Inline Fuel Strainer Replacing, Cummins Engine	47–08

47–01 Diesel Fuel Tank Draining and Vent Checking

Remove the plug or open the drain valve at the bottom of the fuel tank, and allow the tank to drain until all traces of water and sediment have disappeared; install the plug or close the drain valve.

On vehicles with a quarter-turn fuel cap, check to be sure that the vent line at the inboard side of the fuel tank is clean and not plugged.

47–02 Fuel/Water Separator Element Replacing

Alliance

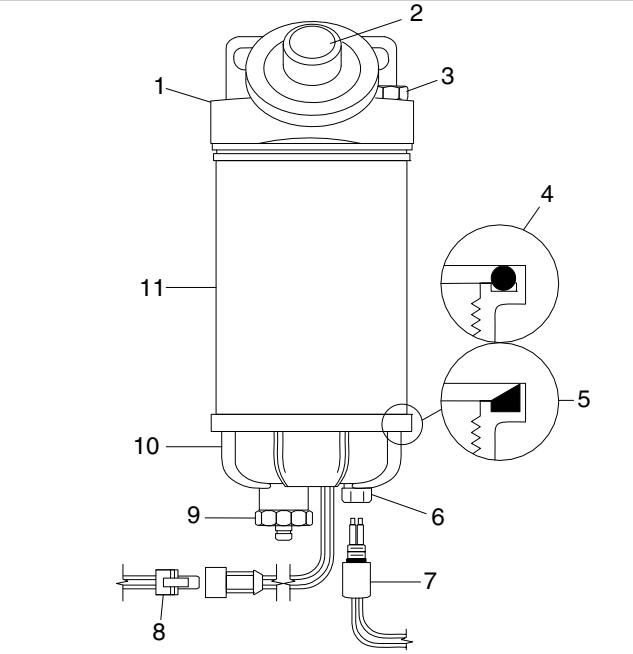
The only maintenance necessary on an Alliance fuel/water separator is to replace the filter element.

⚠ WARNING

Diesel fuel is flammable and can ignite if exposed to an open flame, intense heat, or other ignition source. Do not drain fuel near, or expose fuel vapor to open flame or intense heat. Exposure to open flame or intense heat could start a fire, possibly resulting in personal injury or property damage. When working on a fuel system, have a fire extinguisher within easy reach.

1. Drain off some fuel by loosening the vent plug and opening the drain valve. See **Fig. 1**.
2. Disconnect the water sensor and heater connections if equipped.
3. Remove the element and bowl together, by turning counterclockwise.
4. Remove the bowl from the element and clean the O-ring seating surface.
5. Apply a coating of clean fuel or motor oil to the new O-ring and element seal.
6. Spin the bowl onto the new element, then spin them both onto the filter head, snugly, by hand only.

IMPORTANT: Do not use tools to tighten the bowl and element.



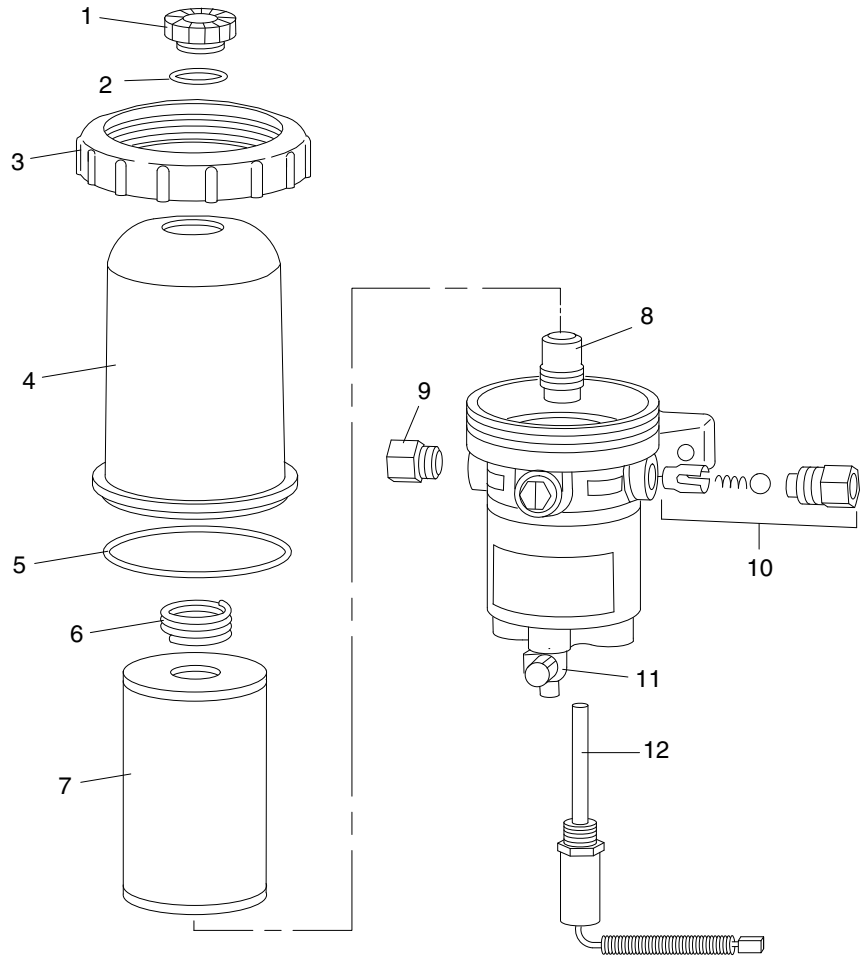
1. Mounting Head
2. Fuel Primer Pump
3. Vent Plug
4. Bowl O-Ring
5. Bowl Gasket
6. Bowl Probe Plug
7. Water Sensor Probe
8. Heater Connector
9. Drain Plug
10. Sight Bowl
11. Filter Element

Fig. 1, Alliance Fuel/Water Separator

7. Connect the water sensor and heater connectors if equipped.
8. If equipped with a primer pump, prime the fuel/water separator.
   - 8.1 Loosen the vent plug. Then operate the primer pump until the fuel purges at the vent plug.
   - 8.2 Close the vent plug.
9. Start the engine and check for fuel leaks.
10. Shut down the engine and correct any fuel leaks.

Davco Fuel Pro® 232 and 233

Replace the fuel/water separator element, shown in **Fig. 2**, only when the filter element is completely covered.



1. Filter Vent
2. Vent Seal
3. Filter Collar
4. Filter Cover
5. Cover Seal
6. Filter Spring
7. Filter Element
8. Temporary Filter Stud
9. Fuel Outlet
10. Check Valve Fuel Inlet
11. Drain
12. Electric Filter Preheater (optional)

Fig. 2, Davco Fuel Pro® 232 and 233

⚠ WARNING

Diesel fuel is flammable and can ignite if exposed to an open flame, intense heat, or other ignition source. Do not drain fuel near, or expose fuel vapor to open flame or intense heat. Exposure to open flame or intense heat could start a fire, possibly resulting in personal injury or property damage. When working on a fuel system, have a fire extinguisher within easy reach.

1. Drain the fuel below the collar level.
2. Using Davco wrench 232002, remove the filter collar. Then remove the filter cover.
3. Remove the element and dispose of it properly.
4. Install a new element. Make sure the grommet is in place on the filter stud.
5. Install a new cover seal on the filter cover.
6. Using the collar, attach the filter cover with the spring to the base.

IMPORTANT: Tighten the collar by hand only.

7. Remove the filter vent. Then fill the fuel/water separator with fuel until the fuel level is 1 inch (2.5 cm) above the collar.
8. Install the filter vent on the fuel/water separator.
9. Start the engine and raise the rpm for one minute to purge air.

Davco Fuel Pro® 382

Replace the fuel/water separator element only when the filter element is completely covered.

⚠ WARNING

Diesel fuel is flammable and can ignite if exposed to an open flame, intense heat, or other ignition source. Do not drain fuel near, or expose fuel vapor to open flame or intense heat. Exposure to open flame or intense heat could start a fire, possibly resulting in personal injury or property damage. When working on a fuel system, have a fire extinguisher within easy reach.

1. Drain the fuel below the collar level. See **Fig. 3**.
2. Using Davco wrench 380134 or 382002, remove the filter collar. Then remove the filter cover.
3. Remove the element and dispose of it properly.
4. Install a new element. Make sure the grommet is in place on the filter stud.
5. Install a new cover seal on the filter cover.
6. Using the collar, attach the filter cover with the spring to the base.

IMPORTANT: Tighten the collar by hand only.

7. Remove the filter vent. Then fill the fuel/water separator with fuel until the fuel level is 1 inch (2.5 cm) above the collar.
8. Install the filter vent on the fuel/water separator.
9. Start the engine and raise the rpm for one minute to purge air.

47–03 CNG Fuel Block Housing Draining

⚠ WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 8 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Shut off the fuel supply at the fuel tanks. Vent the system.

Remove the drain nut at the bottom of the engine internal fuel filter, which is mounted on the left-hand side of the engine.

See the engine manufacturer's operation and maintenance manual for further information.

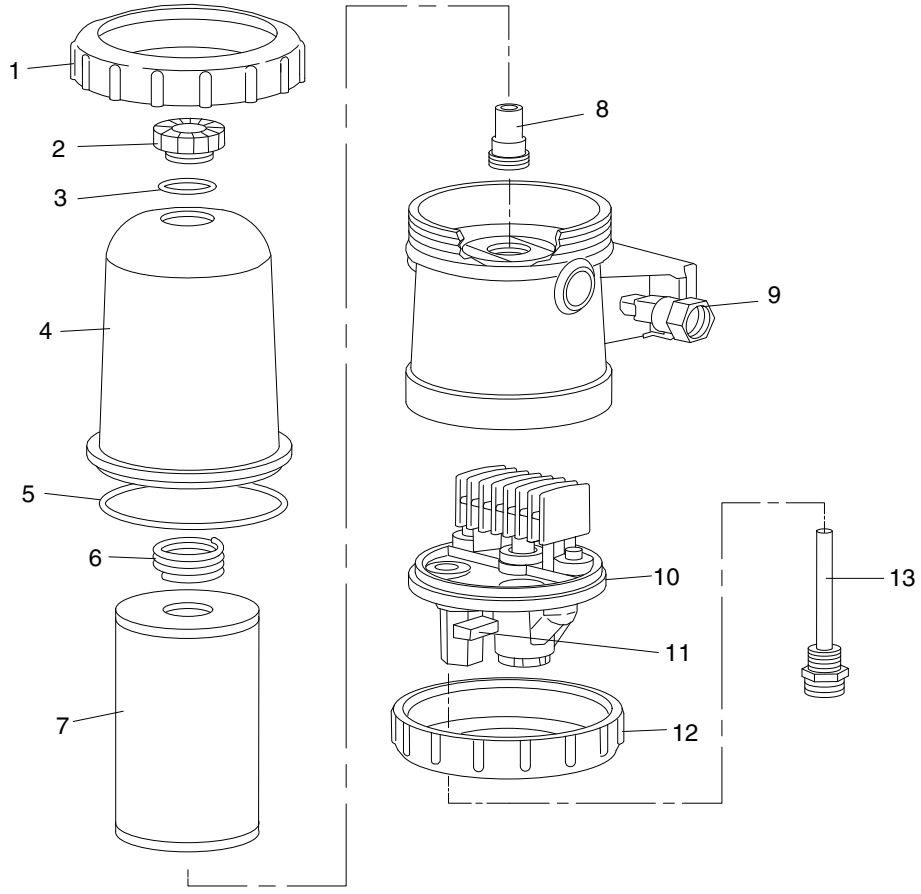
47–04 CNG Fuel Leak Testing

⚠ WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 8 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Inspect and test the fuel tanks and the fuel lines. Use a natural gas detector to check for any leaks.

Replace leaking fuel tanks; repair or replace any lines or connections that are leaking. For procedures and safety precautions, see **Group 47** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.



1. Filter Collar
2. Filter Vent
3. Vent Seal
4. Filter Cover
5. Cover Seal
6. Filter Spring
7. Filter Element
8. Temporary Filter Stud
9. Check Valve Fuel Inlet
10. Fluid Heater/Bottom Plate and Seal
11. Drain
12. Bottom Plate Collar
13. Electric Heater (optional)

Fig. 3, Davco Fuel Pro® 382

47–05 CNG Fuel Tank Visual Inspecting

⚠ WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 8 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Each fuel tank must be visually inspected at specified intervals for external damage and deterioration. The inspection must be performed by a qualified person, in accordance with the manufacturer's established reinspection criteria and Compressed Gas Association documents.

Perform this maintenance procedure as indicated in the maintenance interval chart in this manual. See **Table 1** for the remedies to any damage found on

the tank. See **Group 47** of the *Shuttle Bus Chassis Workshop Manual* for tank repair procedures, or take the vehicle to an authorized Freightliner dealer.

CNG Tank Visual Inspection		
Damage	**Condition**	**Remedy**
Abrasion on the Fiberglass Wrap	Less Than 0.010 Inch (0.4 mm) Deep	No repair needed.
	More Than 0.010 Inch (0.4 mm) But Less Than 0.030 Inch (1.2 mm) Deep	Repair.
	More Than 0.030 Inch (1.2 mm) Deep	Replace tank.
Cuts in the Fiberglass Wrap	Less Than 0.020 Inch (0.8 mm) Deep	No repair needed.
	More Than 0.020 Inch (0.8 mm) But Less Than 0.030 Inch (1.2 mm) Deep	Repair if less than 8 inches (200 mm) long.
	More Than 0.030 Inch (1.2 mm) Deep	Replace tank.
Dents on Metal Ends	Less Than 0.060 Inch (1.6 mm) Deep	No repair needed.
	More Than 0.060 Inch (1.6 mm) Deep	Replace tank.
Gouges on Metal Ends	Bare Metal is Exposed	Replace tank.
Chipped Paint on Tank Ends	No Gray Primer Seen	No repair is needed.
	Gray Primer Seen, But Not Damaged	Repair with two-part epoxy resin.
	Gray Primer Damaged	Repair. Sand and remove rust, clean with pre-paint solvent, apply cold-galvanizing zinc primer and apply two-part epoxy resin.
Stress Cracks from Acid	Cracks in Fiberglass	Remove tank for inspection if exposed to acid. Replace if cracks are seen. Replace strap gaskets if exposed to acid.
Strap Gaskets	Gaskets Damaged or Missing	Approved gaskets must be installed between strap and tank. Replace strap gaskets if exposed to acid.
Tank Shield	Shield is Damaged	Repair or replace shield.
Tank is Old	Tank is 15 Years Old	Replace tank after 15 years from date on label.
Vehicle Was in Accident or Fire	Tank Was Hot or Damaged from Impact	Replace tank or remove tank and test.

Table 1, CNG Tank Visual Inspection

47–06 CNG High-Pressure Fuel Filter Replacing

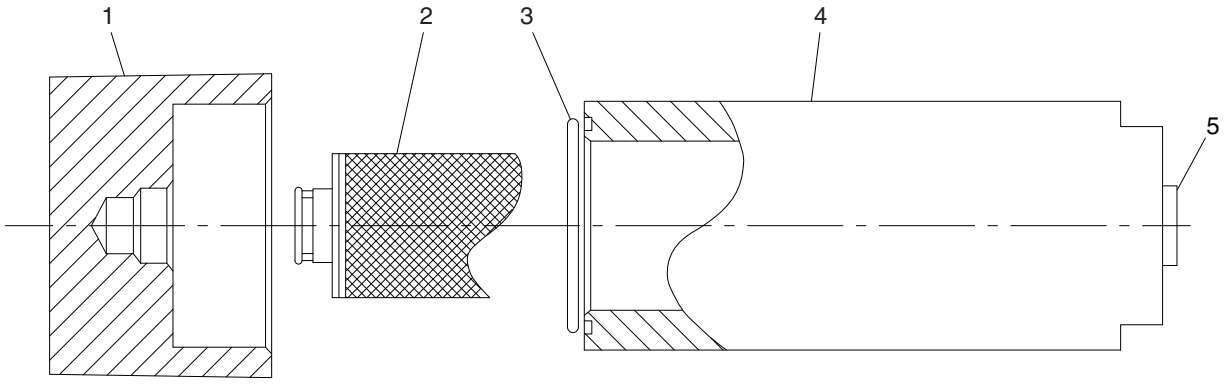
⚠ WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 8 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

The high pressure fuel filter is located inside of the left-hand frame rail, near the rear of the fuel tank.

1. Shut off the fuel supply at the tanks.
2. Vent the fuel supply system.
3. After the system has been vented, remove the filter housing. See **Fig. 4**.

4. Remove and discard the O-ring used to seal the filter housing.
5. Remove and discard the filter element.



1. Fuel Filter Head
2. Filter Element
3. O-Ring
4. Filter Housing
5. Filter Drain

Fig. 4, CNG High-Pressure Fuel Filter Assembly

6. Install the new element and press it into place.
7. Install the new O-ring.
8. Apply a thread lubricant to the housing threads, and screw the filter housing onto the filter head.
9. Check for leaks using a natural gas detector.
10. Tighten the filter housing.
11. Turn the fuel supply on at the tanks.

47–07 CNG Low-Pressure Fuel Filter Replacing

⚠ WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 8 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

The low pressure fuel filter is located inside of the left-hand frame rail, near the center of the fuel tank.

Turn the valve counterclockwise to close the filter drain.

1. Shut off the fuel supply at the tanks.
2. Vent the fuel supply system.
3. After the system has been vented, remove the filter bowl. See **Fig. 5**. Using a 26-mm wrench, remove the bowl nut. Then remove the bowl, the element retainer, and the filter element.

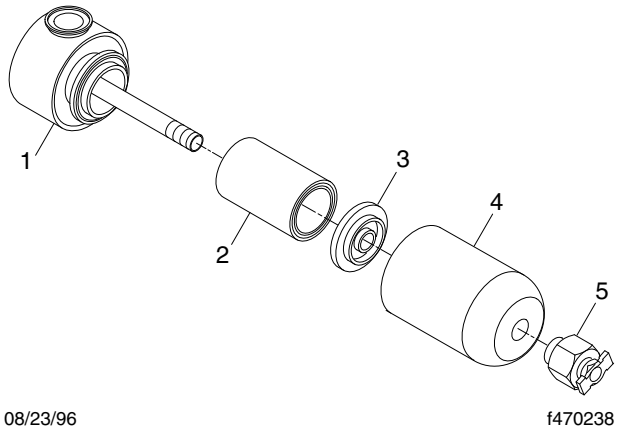
NOTE: Be sure that the O-ring is positioned properly inside of the filter head.

4. Install the new element, the element retainer, the bowl, and the bowl nut.
5. Turn the fuel supply on at the tanks.

47–08 Inline Fuel Strainer Replacing, Cummins Engine

NOTE: Vehicles with a Cummins engine have an inline fuel strainer located on the left-hand side of the engine.

1. Remove the tie bands that secure the fuel strainer.



1. Fuel Filter Head
2. Filter Element
3. Element Retainer
4. Filter Bowl
5. Bowl Nut

Fig. 5, CNG Low-Pressure Fuel Filter Assembly

IMPORTANT: The fuel flow arrow on the fuel strainer must be pointed toward the engine.

2. Remove the strainer, and replace it with a new one.
3. Secure the fuel strainer with tie bands.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Exhaust System Inspecting (Noise Emission Control)	49–01

49–01 Exhaust System Inspecting (Noise Emission Control)

The exhaust system must be free of leaks, binding, grounding, and excessive vibrations. In addition to inspecting the exhaust system at the scheduled maintenance interval, inspect the exhaust system if the noise level of the vehicle has increased. Replace parts that show leakage, wear, or damage, with genuine Freightliner parts.

These conditions are usually caused by loose, broken, or misaligned clamps, brackets, or pipes. If any of these conditions exist, check the exhaust system components and alignment. Align or replace as necessary. For alignment or adjustment instructions, see **Group 49** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

EPA10 Exhaust System

Definitions of Aftertreatment System (ATS) Terms

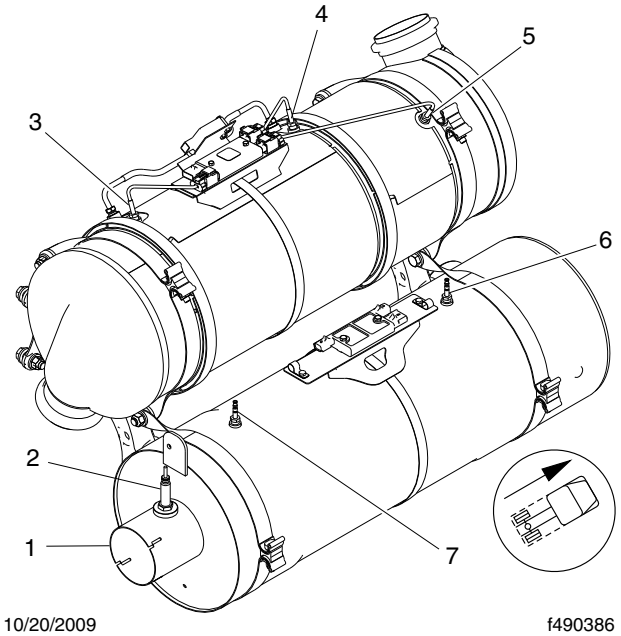
Refer to the following list of definitions of ATS terms and components.

- Aftertreatment System (ATS)—the entire exhaust system from the turbocharger to the tail pipe, including the Selective Catalytic Reduction (SCR) components.
- Aftertreatment Device (ATD)—a device that removes pollutants from exhaust gas after the gas leaves the combustion chamber.
- BlueTec®—Daimler's proprietary SCR technology.
- Diesel Oxidation Catalyst (DOC)—a flow-through device that enhances the oxidation of hydrocarbons in the ATD.
- Diesel Particulate Filter (DPF)—a component in the ATD that traps particulate matter from the exhaust gas.
- Diesel Exhaust Fluid (DEF)—the chemical agent that reacts with the exhaust gases in the SCR to reduce NOx.
- DEF Pump—filters and supplies DEF to the DEF metering unit.
- DEF Tank—holds DEF and regulates its temperature.
- DEF Metering Unit—mixes DEF with compressed air, and meters this mixture into the exhaust flow via an injection nozzle.
- SCR Catalyst—the housing containing a treated ceramic flow-through block where the DEF and exhaust gases undergo selective catalytic reduction.
- Selective Catalytic Reduction (SCR)—a process used to reduce NOx emissions.

Inspection

IMPORTANT: The Environmental Protection Agency's 2010 regulations mandate lowered exhaust emissions, thus requiring exhaust system components that reduce emissions. In particular the aftertreatment device (ATD), which is part of the aftertreatment system (ATS), requires special attention during regularly scheduled maintenance inspections. See **Fig. 1** and **Fig. 2** for Cummins ATD sensor locations. If any discrepancies are discovered, refer to the engine manufacturer's service literature for repair instructions.

1. Check for leakage at the clamp that attaches the exhaust pipe to the turbocharger exhaust outlet. If leakage exists, tighten the nut on the clamp to the required torque. If leakage persists, install a new clamp.
2. Check the exhaust pipe, bellows, and each exhaust seal clamp for leakage, wear, cracks, or damage. Replace damaged components as needed. If leakage exists at a clamp, tighten the nuts to the required torque. If leakage persists, install a new exhaust seal clamp. Do not reuse seal clamps. Once a seal clamp is loosened or removed, it must be replaced.
3. If present, check the condition of the insulation material around the exhaust pipe between the turbocharger and the ATD.
4. Check the ATD mounting bands for tightness. Tighten to 30 lbf·ft (41 N·m) if needed. Do not overtighten.
5. Check for leaks around the clamps that attach the ATD in the ATS, and around the clamps that



1. Exhaust Outlet
2. SCR Outlet NOx Sensor
3. DPF Outlet Pressure Sensor
4. DPF Intake Pressure Sensor
5. DPF Inlet Temperature Sensor
6. SCR Inlet Temperature Sensor
7. SCR Outlet Temperature Sensor

Fig. 1, Cummins ATD Sensor Locations, Top Side-by-Side Mounting

retain the DPF in the ATD. No leaks are allowed anywhere in the system.

6. Check all sensors attached to the ATD for leaks or damaged wires. No leaks are allowed.
7. Check the DPF exterior surface for dents or other damage. A dent over 3 inches (76 mm) in diameter and 1/4-inch (6-mm) deep could cause internal damage to the DPF, causing it to malfunction.
8. Check the SCR catalyst for dents and other damage.
9. Check for heat discoloration on the surface of the ATD. Heat discoloration may indicate internal damage; especially around the DPF.

NOTE: Diesel exhaust fluid creeps, causing white crystals to form around the line fittings. The presence of crystals does not mean the system has a leak. Replacing fittings or troubleshooting components is not necessary unless there is a system failure or a fault code.

10. Check the DEF tank, pump, metering unit, and lines for leaks. See **Group 49** of the *Shuttle Bus Chassis Workshop Manual* for repair procedures.
11. Check any wires, lines, or hoses within 4 inches (10 cm) of the exhaust system for heat damage. Repair or reroute as needed.

Diesel Exhaust Fluid (DEF) Filter Replacement

The Environmental Protection Agency's 2010 regulations require lower nitrogen oxide (NOx) exhaust emissions. Selective catalytic reduction (SCR) uses diesel exhaust fluid (DEF) to lower NOx emissions in the vehicle exhaust. A filter in the DEF pump prevents clogging of the DEF metering unit injection nozzle.

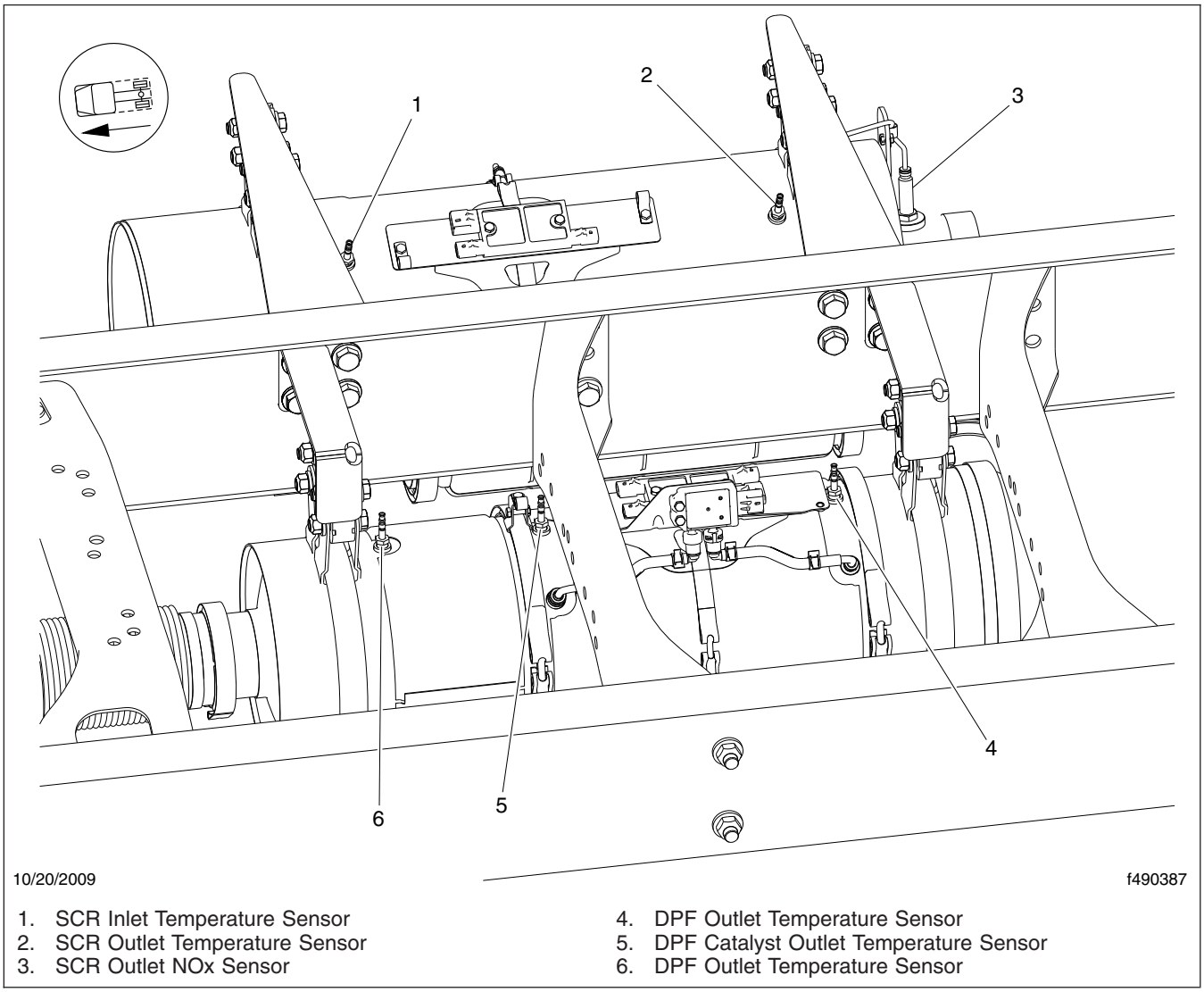
See the engine manufacturer's maintenance manual for DEF filter replacement instructions and maintenance intervals.

EPA07 Exhaust System

Definitions of ATS Terms

Refer to the following list of definitions of ATS terms and components.

- Aftertreatment System (ATS)—the entire exhaust system from the turbocharger to the exhaust stack or tail pipe.
- Aftertreatment Device (ATD)—a muffler-like canister that houses a DPF and sensors.
- Diesel Particulate Filter (DPF)—a filter that collects and holds particulate matter (soot and ash).
- Diesel Oxidation Catalyst (DOC)—oxidizes hydrocarbons and reduces NOx.
- Sensors—detect temperatures and pressure within the ATS.
- Diffuser—a device, used as a deflector, for distributing, mixing, and reducing the velocity of air flow.



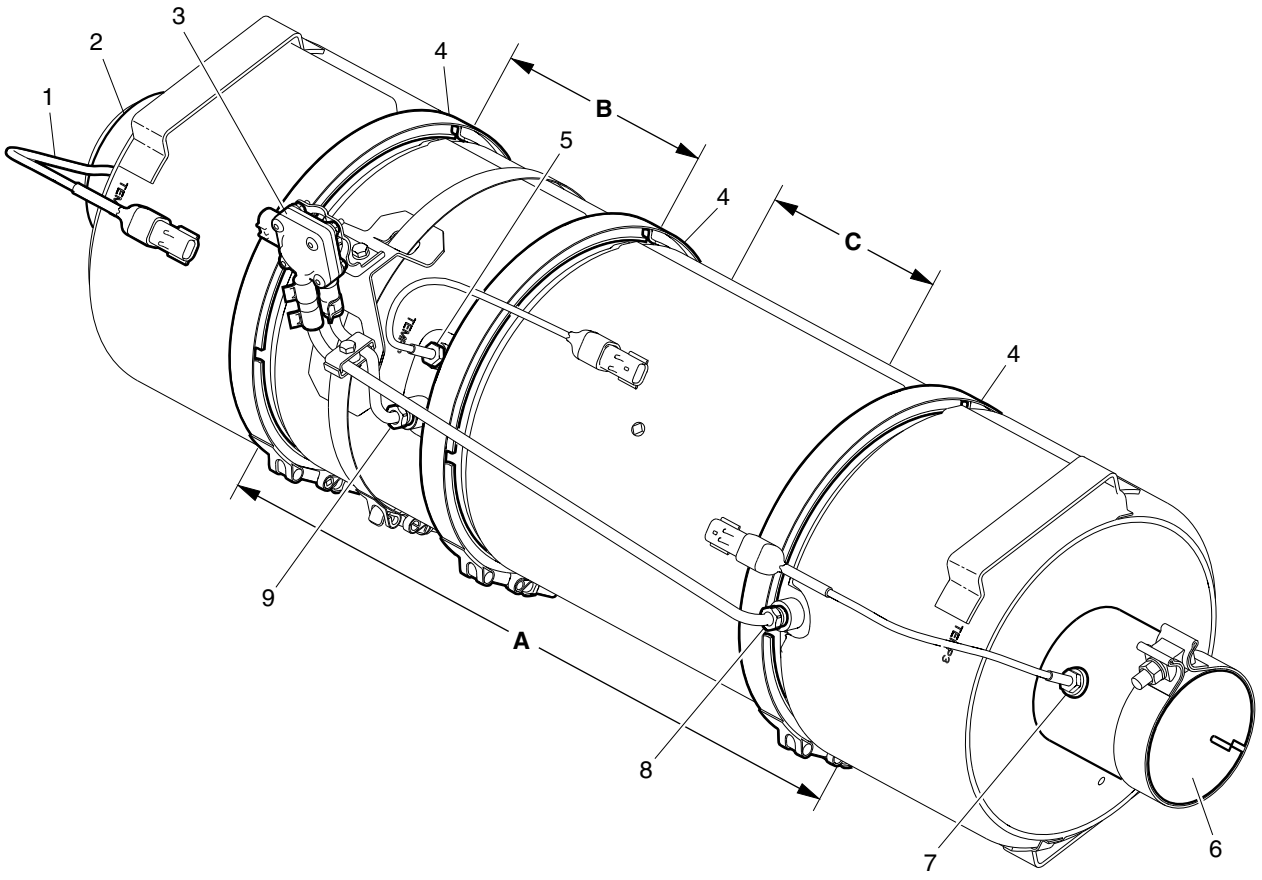
1. SCR Inlet Temperature Sensor
2. SCR Outlet Temperature Sensor
3. SCR Outlet NOx Sensor
4. DPF Outlet Temperature Sensor
5. DPF Catalyst Outlet Temperature Sensor
6. DPF Outlet Temperature Sensor

Fig. 2, Cummins ATD Sensor Locations, Side-by-Side Mounting

Inspection

IMPORTANT: The Environmental Protection Agency's 2007 regulations require lower exhaust emissions, thus requiring new exhaust system components. See **Fig. 3**. In particular the aftertreatment device (ATD), which is part of the aftertreatment system (ATS), requires special attention during regularly scheduled maintenance inspections. If any discrepancies are discovered, refer to the engine manufacturer's service literature for repair instructions, or take the vehicle to an authorized Freightliner service facility for repair.

1. Check the leakage at the clamp that attaches the exhaust pipe to the turbocharger exhaust outlet. If leakage exists, tighten the nut on the clamp to the required torque. If leakage persists, install a new clamp.
2. Check the exhaust pipe, bellows, and each exhaust seal clamp for leakage, wear, cracks, or damage. Replace damaged components as needed. If leakage exists at a clamp, tighten the



A. Inspect this area of the canister for dents.
B. DOC Area
C. DPF Area

1. Inlet Temperature Sensor
2. Marmon Fitting at Inlet from Turbocharger
3. Sensor Housing
4. DPF V-Band Mounting Clamps
5. Inlet Temperature Sensor
6. Exhaust Outlet to Diffuser
7. Outlet Temperature Sensor
8. DPF Outlet Pressure Sensor
9. DPF Intake Pressure Sensor

Fig. 3, Cummins Aftertreatment Device

nuts to the required torque. If leakage persists, install a new exhaust seal clamp. Do not reuse seal clamps. Once a seal clamp is loosened or removed, it must be replaced.

3. If present, check the condition of the insulation material around the exhaust pipe between the turbocharger and the ATD.
4. Check the ATD mounting bands for tightness. Tighten 30 lbf·ft (41 N·m) if needed. Do not overtighten.
5. Check for leaks around the clamps that attach the ATD in the ATS, and around the clamps that retain the DPF in the ATD. No leaks are allowed anywhere in the system.
6. Check all sensors attached to the ATD for leaks or damaged wires. No leaks are allowed.

7. Check the DPF exterior surface for dents or other damage. See **Fig. 3**, Ref. A. A dent over 3 inches (76 mm) in diameter and 1/4-inch (6-mm) deep could cause internal damage to the DPF, causing it to malfunction.
8. Check for heat discoloration on the surface of the ATD. Heat discoloration may indicate internal damage; especially around the DPF.
9. Check any wires, lines, or hoses within 4 inches (10 cm) of the exhaust system for heat damage. Repair or reroute as needed.

Index, Alphabetical

Title of Maintenance Operation (MOP)	MOP Number
Battery Voltage Checking	54–02
Ground Cables Checking and Cleaning	54–01

54–01 Ground Cables Checking and Cleaning

Check that the ground cables are clean, undamaged, and tight. If necessary, disconnect them and clean the mating surfaces with a soda solution. Then, connect them securely. Spray the ground cable connections with dielectric red enamel. See **Table 1** for approved protectants.

Approved Dielectric Protectants	
Protectant Material	**Approved Brand**
Dielectric Grease	Lubriplate FLP DS–ES
Dielectric Red Enamel Spray-On Application	3M 1602 IVI-Spray Sealer; order from the PDC
	Spray-On B–6–665
Dielectric Red Enamel Brush-On Application	Glyptal 1201EW-Low VOC, Red; order at **www.glyptal.com** or 1-800-GLP-1201

Table 1, Approved Dielectric Protectants

54–02 Battery Voltage Checking

Check the battery open circuit voltage using an accurate voltmeter. If the voltmeter registers 12.5V or below, fully charge the battery to 12.65V. A fully charged battery will have a voltage of 12.65V with the charger disconnected.

Index, Alphabetical

Title of Maintenance Operation (MOP) **MOP Number**

Air Conditioner Checking, R-134a Refrigerant System 83–01

83–01 Air Conditioner Checking, R-134a Refrigerant System

Preliminary Checks

1. Park the vehicle on a level surface, shut down the engine, apply the parking brake, and chock the tires.
2. Make sure that the refrigerant compressor drive belt is not damaged and that it is correctly tensioned. Also check the tightness of the compressor mounting fasteners. For instructions and torque values, see **Group 01** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
3. Using a feeler gauge, check for correct clutch clearance. For instructions, see **Group 83** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
4. Inspect the compressor clutch coil wire. Check the connector for damage or looseness. Replace the wire if it is damaged.
5. Check for broken, burst, or cut hoses. Also check for loose fittings on all parts.

⚠ WARNING

Wear eye protection when using compressed air to clean parts, as permanent harm to eyes could result from flying debris.

6. Check for a build-up of road debris on the condenser fins. Using a whiskbroom and air pressure, or a spray of soapy water, carefully clean off the condenser; be careful not to bend the fins.

Cooling Checking

1. Start the engine and set engine speed at 1500 rpm. Close the doors and windows.

IMPORTANT: When outside temperature and humidity are high it will take longer to cool the interior, especially if fresh-air vents are left open.

2. Turn on the air conditioner; set the controls at maximum cooling and blower speed.
3. Allow the system to run for at least 10 minutes (longer on hot and humid days).
4. Check air flow from the vents. If there is not enough air flow, check the air intake vent for blockage and the blower motor for proper operation.

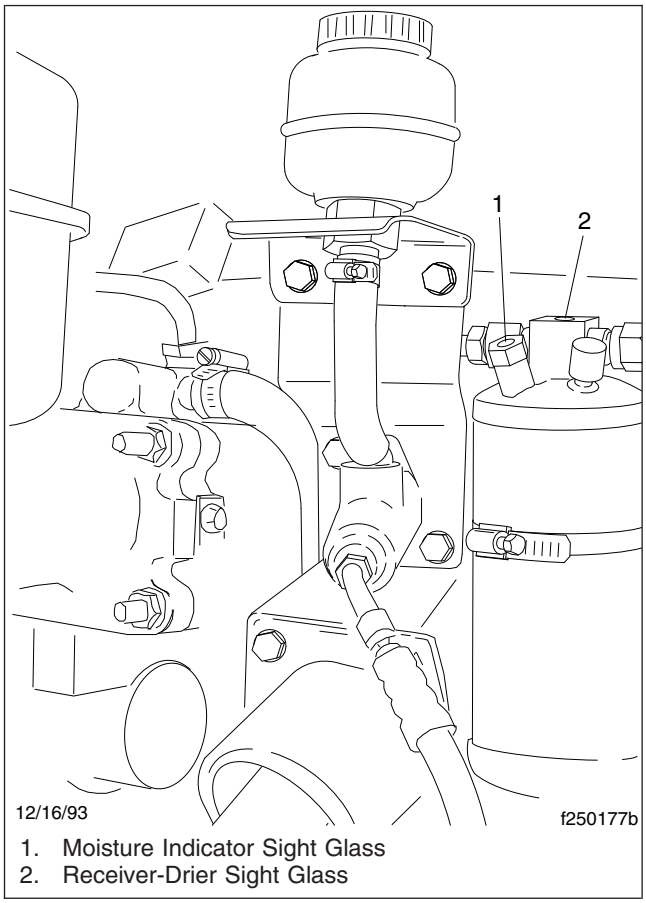
   If the air flow is not cold enough, see **Group 83** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
5. Carefully feel the system lines.
   - The compressor discharge line should feel hot.
   - The condenser inlet line should be noticeably warmer than the outlet line.
   - The line from the condenser should feel warm.
   - The inlet and outlet lines of the receiver-drier should be about the same temperature.
   - The line from the receiver-drier to the evaporator should feel warm.
   - The line from the evaporator to the compressor should feel cold.

NOTE: Oily spots on the lines or at the fittings could indicate a system leak.

Refrigerant Checking

If equipped with a moisture indicator sight glass, check the color of the moisture indicator. See **Fig. 1**, Item 1.

If the moisture indicator is a deep cobalt blue, the refrigerant charge is dry. If the indicator is *not* blue, the system is contaminated with water; recover the refrigerant, replace the receiver-drier, evacuate the system, and add a full refrigerant charge. Follow the instructions in **Group 83** of the *Shuttle Bus Chassis Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.



1. Moisture Indicator Sight Glass
2. Receiver-Drier Sight Glass

Fig. 1, Receiver-Drier